SPRING-THAW NITROUS OXIDE EMISSIONS FROM REED CANARYGRASS ON WET MARGINAL SOIL IN NEW YORK STATE

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

Cedric Wood Mason

August 2014

ABSTRACT

In temperate climates, a significant fraction of annual emissions of nitrous oxide (N_2O) from agricultural land occurs during soil thaw. The objective of this study is to determine the impact of conversion of long-term fallow grassland to perennial grass bioenergy crops on N_2O emissions during spring-thaw, and to identify field-scale features that influence emissions. We measured mid-afternoon fluxes daily from March 27th to April 7th 2013 from fallow and reed canarygrass over a short topological gradient using static chambers. Soil temperature, volumetric water content, and above-ground biomass were also observed, as were hourly air temperature and precipitation. Hot-moment analysis, non-parametric statistics and modeling results show that in the reed canarygrass, the topologically low subplots exhibited significantly elevated emissions compared to the fallow. Our results suggest that conversion of fallow grassland to perennial grass cropping systems for bioenergy or other uses could increase spring-thaw N_2O emissions in wetness prone areas.

BIOGRAPHICAL SKETCH

Cedric Mason was born in 1981 in Denver Colorado, the second of five children, and lived most of his childhood and adolescence in Massachusetts and Vermont. In school he excelled at physical science and mathematics but also developed and cultivated a strong interest in the natural world. He studied Physics and Music at Franklin and Marshall College, and graduated with a B.A. in 2003.

From 2003 to 2007, Cedric lived in New York City where he worked as a lab assistant at the Lamont Doherty Earth Observatory, helping to conduct paleomagnetic research. In 2007, He returned to Vermont to pursue his growing interest in sustainable agriculture and worked for several years at Cedar Circle Farm on fruit and vegetable production crews.

Cedric moved to Ithaca NY in 2011 to join the Soil and Water Group at Cornell University.

ACKNOWLEDGEMENTS

I would like to thank my parents, Bruce Mason and Melissa Warner for their unwavering support during my first 33 years of my life, and my siblings and friends for helping me through the tough times. I am very grateful to my academic advisor Dr. Tammo Steenhuis, my supervisor and project director Dr. Brian Richards, and to my mentor Dr. Cathelijne Stoof. Thanks to Lauren McPhillips, Shree Giri, and Marina Molodovskaya who provided advice regarding the gas chromatography techniques used in this study. Thanks to the Cornell Cross-scale Biogeochemistry IGERT program for support and resources. This project is funded in part by USDA/NIFA Agriculture and Food Research Initiative grant number 2010-03869, with additional funds provided through Cornell University's College of Agriculture and Life Sciences (CALS).

TABLE OF CONTENTS

Biographical Sketch…………………………………………………………………………iii

Acknowledgements…..iv

Table of contents…………………………………………………………………………..v

List of figures……………………………………………………………………………vii

Preface……………………………………………………………………………….viii

Spring-thaw nitrous oxide emissions from reed canarygrass on wet marginal soil in New York State………………………………………………………………………………..1

Concluding remarks and recommendations……………………………………….............22

Appendix……………………………………………………………………………….24

Supplementary Images…………………………………………………..…25

Protocol for sample collection and analysis……………………………......33

Field and lab log…………………………………………………….....…38

Data………………………………………………………………………...…41

Raw gas chromatography data…………………………..…43

Molar volume data……………………………………….68

Flux data…………………………………………………69

Above-ground biomass data………………………………..75

Soil moisture and temperature………………………….....…76

Meteorological data……………………………………....…79

R code for processing data and performing statistical analysis of fluxes…..85

Script 1…………………………………………………..…86

Script 2……………………………………………………………..92

Script 3…………………………………………………………100

Script 4…..103

Script 5……………………………………………………….....110

Script 6…………………………………………………………116

Works cited……………………………………………………….…………………………………117

LIST OF FIGURES

Figure 1…..6

Figure 2…………………………………………………………………………………7

Figure 3……………………………………………………………………………..12

Figure 4………………………………………………………………………..…14

Figure 5……………………………………………………………………..……15

Supplementary Image 1……………………………………………………………….26

Supplementary Image 2……………………………………………………………......27

Supplementary Image 3……………………………………………………………......28

Supplementary Image 4……………………………………………………………….29

Supplementary Image 5……………………………………………………………...…..30

Supplementary Image 6……………………………………………………………….31

Supplementary Image 7……………………………………………………………….32

PREFACE

When I first began to study the subject of nitrous oxide emissions from soils, I knew very little about the topic or the various aspects that it relates to. In conducting this research as part of my graduate education, I have found the subject is very multifaceted, and relates to and overlaps with many other areas including crop and soil science, hydrology, microbiology and biochemistry, as well as those of policy and agriculture, and climate change. As a result, this subject of study has been an excellent introduction to the field of Biological and Environmental Engineering and exhibits that this field truly sits at the nexus of human, agricultural, and environmental systems.

The procedures that I describe in this document could be applied to many different situations where terrestrial nitrous oxide emissions are measured. The application here to bioenergy cropping systems is especially relevant in todays world where the human population is rising and the impacts of resource consumption are becoming more evident in the form of environmental deterioration and climate change. It is likely that agriculture will continue to develop in the coming decades as the availability of resources, and the values of our society continue to change. In this context, the findings of this research are valuable for understanding the impacts of agricultural production of perennial grasses for bioenergy and other end uses and hopefully will find a place in guiding the development of agricultural practices and policy.

In this thesis, I provide a final paper of my findings with the hope that it will soon be accepted for publication in a peer-review journal. While the paper is the main focus, I have also included supplementary materials in the appendix that give more information on the methods used for data collection, processing, analysis and interpretation. I also include the raw data that was collected, computed fluxes, and additional observations and calculations that are relevant to this research and may be of interest to the reader.

Spring-thaw nitrous oxide emissions from reed canarygrass on wet marginal soil in New York State*

Introduction:

Reed canarygrass and other second generation bioenergy crops are considered a viable source of renewable energy and are currently being studied and developed for expanded use (1). Life-cycle analysis (LCA) is used to evaluate the overall efficiency of second generation bioenergy streams in comparison to traditional fossil fuels and other bioenergy feedstocks (2). A complete LCA takes into account all costs of production inputs as well as environmental impacts and energy yield. It is presumed that 2nd generation bioenergy crops are more efficient as a feedstock than 1st generation crops such as corn or soy because they require fewer inputs of fossil fuel, fertilizer, pesticides, and herbicides and have reduced impacts on soil erosion and ground and surface water pollution and abstraction (2). However, a wide degree of variability has been observed with respect to the environmental performance of 2nd generation bioenergy crops across various sites and climatic conditions (2-4). In addition, little investigation has been conducted into environmental impacts from 2nd generation bioenergy crops grown on sub-prime, wetness-prone farmland in the Northeast U.S. where perennial grasses such as reed canarygrass can be cultivated on marginal soils without competing with food-producing cropland.

A comprehensive LCA for bioenergy crops considers greenhouse gas (GHG) emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (3). Results from the biogeochemical model DAYCENT show that N_2O is the largest GHG source from bioenergy

* Authors: C. W. Mason, C. Stoof, B. K. Richards, D. G. Rossiter, T. S. Steenhuis

crops (1). N_2O has an estimated 100-year global warming potential 298 times that of CO_2 (5). It also degrades earth's stratospheric ozone layer (6) and is recognized as the primary anthropogenic threat in this regard (7). In 2005, agricultural activities accounted for approximately 60% of global anthropogenic N_2O emissions (8); agriculturally managed soils are a primary source (9) with future increases expected due to increased fertilizer and animal manure production globally (8).

N_2O is produced in soils by biochemical processes, most significantly as an intermediary product in the stepwise respiratory denitrification of nitrate to N_2 gas by soil biota under anaerobic conditions (2, 6, 10). Diffusion of intermediate N_2O from the soil before further biochemical reduction results in transmittance of N_2O to the atmosphere. Microbial genesis and diffusion of N_2O is governed by environmental factors within the soil (such as temperature, moisture, E_h (redox potential), PH, dissolved organic carbon (DOC), and inorganic reactive nitrogen) (6, 10) that are in turn determined by primary drivers such as climate, soil properties and vegetation (10). Temporal and landscape scale variation of the primary drivers, their complex linkage to the secondary drivers of microbial metabolism, and the intricate dynamics of microbial communities in soils hinders simple regression analysis that could determine the relationship between agricultural management practices and N_2O emissions (10).

However, empirical models that incorporate ecosystem features based on multiple regression and multivariate data analysis have proved successful, even while ignoring microbial community (6). Parameters considered in these approaches include soil type and parent material, climate, vegetation, topography, temperature, soil moisture and concentration of inorganic nitrogen (6). To cope with the highly episodic nature of N_2O fluxes from agricultural soils, a "hot-moment" approach has been employed. (11, 12). The hot-moment approach statistically identifies extreme emission events that account for a disproportionately large percentage of annual emissions. Relationships between hot-moments and primary ecosystem parameters can then be explored under the assumption that the requisite conditions for N_2O production and atmospheric transmission are present.

In temperate climates, studies have shown that a significant proportion of annual of N_2O emissions occur during spring-thaw (11-14) (15-18). It is thought that the primary source of N_2O from agricultural soils during freeze-thaw events is *de novo* production via denitrification, but trapping of N_2O produced by denitrifiers within nutrient enriched oxygen depleted liquid water films (19), and below surface ice layers during freezing and subsequent release during thaw (20) may also play a significant role in these emissions (18, 21). *De novo* production upon thaw is thought to be facilitated by an increased availability of DOC and nitrate from frost-killed microbial necromass, aggregate disruption, and death of fine roots (18, 19), but this is not significant in all cases (22) and may depend in part on soil type. The degree of nutrient turnover and thus N_2O production upon soil thaw is thought to be related to the intensity and duration of soil freezing (18, 21) and it has been observed that the presence of crops or crop residue on the soil surface can impact N_2O emissions (13, 15, 16, 23). Other management practices of tillage, residue incorporation and fertilizer application have also been shown to affect spring-thaw N_2O emissions if the practices were implemented the previous fall (17, 24, 25). Additionally, the water content of the soil upon thaw affects the diffusion of O_2 to soil microorganisms and plays an important role in the activity of denitrifiers. Thaw induced fluxes from soils have been shown to occur in the range of 60-90% WFPS (11, 26), with an optimum at about 70% (17, 21), and at temperatures over 5°C (26).

The purpose of this study is to (i) observe and quantify N_2O fluxes from perennial grasses during spring-thaw, (ii) determine the effect of conversion of marginal, fallow grassland to reed canarygrass (*Phalaris Arundinacea*) on soil N_2O emissions during spring-thaw, and (iii) investigate field-scale factors that can be used to predict these emissions. With regard to objective (iii), we hypothesize that topographic position, and crop type and quantity of above-ground biomass will act on soil moisture and frost-elevated nutrient levels respectively, and these have been shown to influence N_2O emissions as discussed above.

Methods:

Overview:

We observed static chamber N_2O fluxes from converted soil and adjacent fallow grassland daily from March 27th to April 7th 2013. Hot-moment analysis as well as non-parametric statistics and regression modeling were used to identify topologic and management factors that affect N_2O emissions.

Site description and experimental design:

The site for this study was a seasonally wet, 16-acre field near Ithaca, New York USA (42N 28.20', 76W 25.94'). The field is generally flat with slightly undulating topography broken by the remains of an old surface drainage network comprised of shallow swales; soil drainage class ranges from moderately well drained to poorly drained. Aside from occasional mowing or hay harvesting, during the past 50 years the field has laid fallow due to recurring and seasonal wetness that renders the soil unfit for reliable equipment access or row crop production, and it is in this context that the field is classified as marginal. In July 2011 portions of the field were mowed, plowed, disked and seeded with reed canarygrass (*Phalaris arundinaceae* L., v. Bellevue) (RCG) for bioenergy feedstock, while other areas were left undisturbed as fallow grassland (FGL). The RCG was fertilized in May 2012 with 66 lbs. - N/acre (75 kg – N/ha) fertilizer. In October 2012 the RCG was mowed at a height of approximately 20 cm but was not raked or baled due to low yields resulting from near-drought summer conditions. Because the RCG was left in this manner, the distribution of crop residue was quite variable within those plots; residue was left as it lay after mowing. While the FGL subplots were blanketed with a consistent and substantial layer of partially lodged senescent grass and vegetation, the RCG subplots tended to vary widely in the degree of detritus and crop density, the Low/RCG plots exhibiting patchy, intermittently matted crop residue, crowned vegetation and exposed muddy soil (fig. 1).

Within the field, three plots; A, B and C with dimensions 8.1 x 7.2, 7.9 x 3.4, and 7.9 x 3.8 m respectively, were chosen that allowed side-by-side comparison of adjacent FGL and RCG, and spanned a distinct topological gradient extending from a saturated area. Each saturated area consisted of a shallow depression presented by one of the existing drainage swales, and held several inches of standing water that was sometimes frozen at the surface during the period of data collection. All three plots were mapped as the same soil type (Dalton channery silt loam, thin mantle, 0-3% slopes) (27) and identical sampling designs were applied at each of the three plots. The sampling design was a replicated 2x2 factorial design with topography and crop type as grouping factors (fig. 2). The levels for the crop type class were FGL and RCG, and the levels for the topographic class were High and Low. Each plot contained 4 subplots situated to represent the 4 possible topographic class and crop type combinations.

Data collection and instrumentation:

N_2O fluxes were observed by the static chamber method outlined by Parkin and Venterea (28). Chambers were constructed similarly to those reported by Molodovskaya, Oberg (29) using

Figure 1: Photographs of fallow grassland (FGL) (top), and reed canarygrass (RCG) (bottom) at plot B, taken on April 3rd, 2014 one year after the study. These images indicate the approximate state of the site during the study.

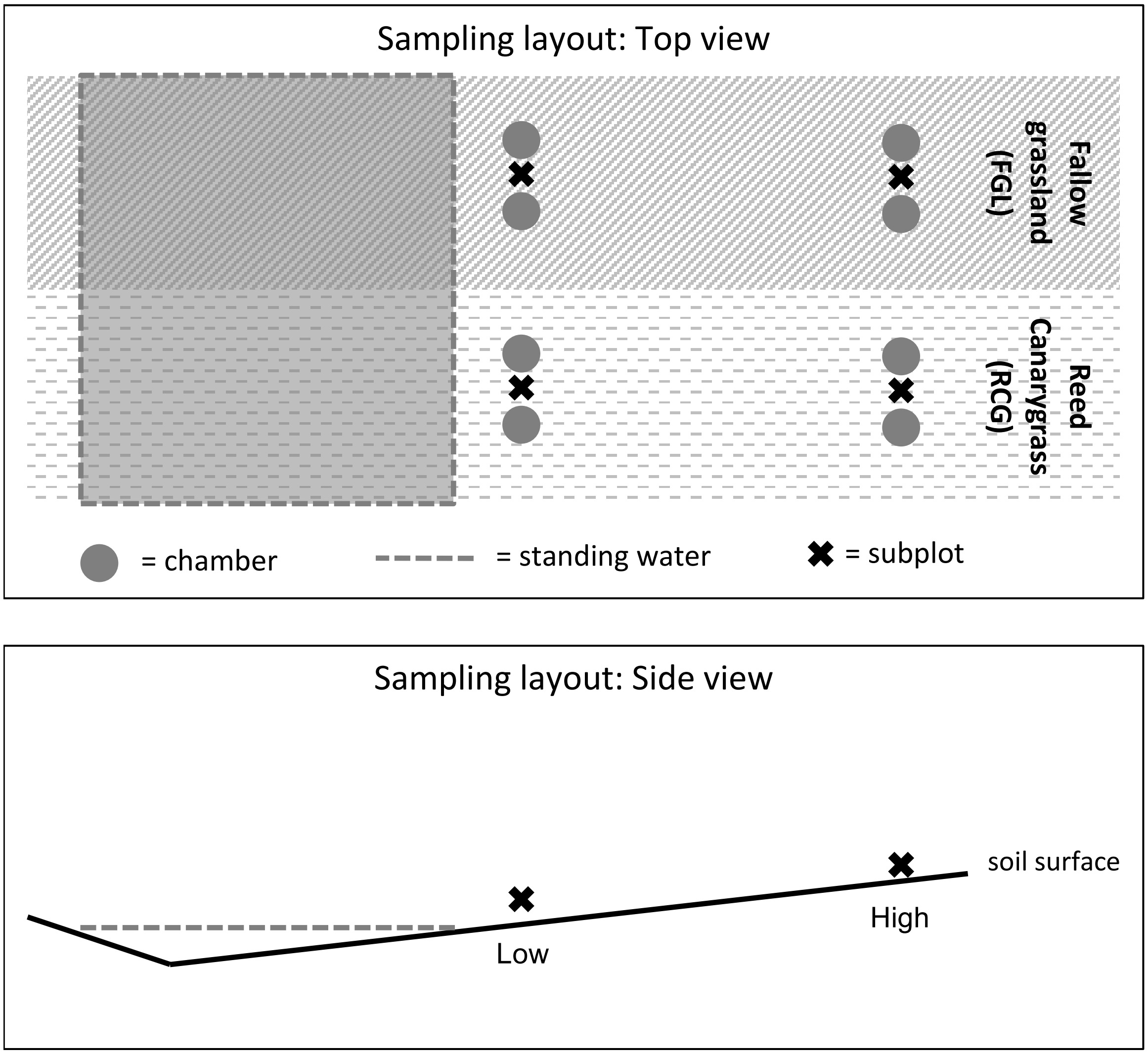


Figure 2: Sampling layout and subplot structure showing crop type (Top view: FGL, RCG), topographic position (Side view: High, Low) at each of the three study plots, A, B and C.

the rims from 5-gallon plastic pails as chamber bases, and 3.5 gallon white plastic pails, each equipped with a butyl rubber septum for sample withdrawal and a vent tube (length: 203mm, width: 6.4mm) for pressure equilibration, as removable chamber covers. Each cover fit snuggly over the rim of the base with a heavy rubber band (dimensions: 305mm x 25mm x 1.6mm, Dykema Bands, McKees Rocks PA) around the base to seal the surfaces. Overall chamber dimensions were 45 cm high with a circular footprint 36 cm in diameter. Pairs of chamber bases were installed less than 1.33 m apart at each subplot on March 25th 2013 and left in place for the duration of the study. The chamber bases in the low subplots were centered approximately 60 cm back from the standing water/ice while in the high subplots they were placed over what appeared to be the driest local areas. In the RCG subplots where crop residue was quite variable, chambers were placed to capture a representative range and degree of residue and vegetation in that subplot. Bases were installed to a depth of 3 to 5 cm with as little disturbance as possible to the subplot by using a custom circular hole saw to cut a circular notch in the soil. Care was taken to preserve the original quantity, quality and arrangement of vegetation and crop residue within and around the chamber base, and to ensure an adequate seal between the base and the soil.

Data were collected daily from March 27th 2013 to April 7th 2013. Beginning at 13:11 (+/- 7.5 minutes) to approximately correspond with peak diurnal soil temperature, we conducted simultaneous measurements of gas fluxes at all chambers in all three plots, with one sampler running a rotating schedule around the site. Four gas samples were withdrawn from each chamber at 0:05, 20:00, 40:00 and 60:00 after applying the chamber cover, the entire course lasting approximately 80 minutes for all 24 chambers. During sampling, 20 mL gas samples were withdrawn from the chambers with a syringe, 15 mL of which were injected immediately into 10 mL glass vials that had been sealed with a butyl rubber stopper and pre-evacuated to -90 kPa.

Vials containing calibration standards were prepared daily in the field from mixes of verified standard gas. Calibration mixes were prepared manually from known gas standards and included 20% oxygen to ensure uniformity in detector response across field samples and calibrations. Gas samples and prepared calibrations were stored together in plastic bags in our lab at room temperature and nitrous oxide concentration determined within 60 days by gas chromatography. Our gas chromatograph (Agilent Technologies 6890N) is operated with splitless injection and is equipped with a μECD detector at 250°C and a supel-Q plot 30 m capillary column with ultrapure He carrier gas at 2.6 mL min^{-1}. An oven temperature of -22°C was maintained using liquid nitrogen cryocooling to separate the N_2O peak. Automatic peak integration was performed with Chemstation™ software. Daily chamber fluxes were calculated using the method outlined by Rochette and Bertrand (30) but without correcting for effects of air humidity (31)(equation 1). Here, $\frac{dC}{dt}$ is the rate of change in chamber concentration of N_2O at t = 0, V is the chamber volume (0.02 m^3), A is the chamber footprint area (0.07 m^2), M_{N2O} is the molecular mass of N_2O, and V_m is the molar volume at chamber pressure and temperature.

$$F_{\mathrm{N2O}} = \frac{dC}{dt}\frac{V}{A}\frac{M_{\mathrm{N2O}}}{V_m}$$

Equation 1

We used the slope from linear least squares regression of sample concentration vs. time which tends to underestimate flux values compared to a higher order regression, but with less sensitivity to measurement noise.

Soil temperature and moisture at each subplot were observed daily immediately following the conclusion of gas flux observation, typically beginning at 14:45. Soil temperature over the top 2.5 cm was averaged from 3 readings of thermocouple thermometers placed between the two chambers at each subplot. Soil moisture over the top 12 cm at each subplot was by time domain reflectometry (TDR) following a similar probe placement pattern as soil temperature. Continuous automatic measurements of precipitation and air temperature were recorded by a tipping-bucket rain gauge (model 3665R, Spectrum Technologies) and a HMP45A/D temperature probe (Vaisala Group) linked to a datalogger at the site. Above-ground biomass (vegetation and crop residue) was collected from within each chamber on April 13th 2013. The total wet biomass from each chamber was weighed and a subsample was weighed and dried at 105° C for 16 hours as recommended by Undersander (32), then reweighed to calculate total dry biomass for each chamber. Sample calibration, flux calculation and data handling were performed using "R" software (version 2.14.1), as were statistical analysis and modeling.

Method detection limit estimation:

To estimate the detection limit of the N_2O flux observations as determined by the static chamber method followed by gas chromatography, we used the Monte Carlo technique. We first selected the initial samples (time = 0.083 min) from the data set. These initial samples are theoretically very close to the ambient concentration of atmospheric N_2O with little spatial variation, the average concentration of the initial samples was 0.303 ppm. The standard deviation of concentrations of the initial samples was calculated for each gas chromatograph sequence and the average standard deviation of all the GC runs was found to be 0.011 ppm.

We then generated 1000 values from the standard normal distribution in matlab™ and multiplied each random value by the standard deviation (0.011 ppm) from the previous step, then added the mean concentration value (0.303 ppm). These simulated concentrations were split into groups of four and assigned times based on the sampling interval for the chamber method used in this study. For each group of four simulated concentrations, the slope of the linear regression was calculated in the same method as for the actual field samples. For each slope, a simulated flux was computed. Finally, the standard deviation of the simulated fluxes was found to be $1.4 * 10^{-7}$ g N_2O m^{-2} min^{-1}. Multiplying by a factor of 1.96 gives the 95% confidence interval and this was calculated as +/- $2.7 * 10^{-7}$ g N_2O m^{-2} min^{-1}, or +/- 10.2 μg N_2O-N m^{-2} hr^{-1}.

Data handling and statistics:

As has been observed in other studies (12, 16), our fluxes were non-normally distributed. We used a hot-moment approach similar to that of Molodovskaya, Singurindy (11) and Corre, vanKessel (12) in recognition of the extreme temporal and spatial variability that is typical of N_2O emission patterns. This approach identifies outliers and qualifies them as hot-moments; instances of sudden biogeochemical response to multiple driving factors. This approach can elucidate the link between field scale factors and sites of intense microbial action in the soil that produce N_2O. We followed the procedure used by Corre, vanKessel (12) to qualify hot-moments as individual flux observations that exceed a threshold set as the median plus 3 times the interquartile range for the dataset.

In addition, we used the Kruskal-Wallace rank sum test and Wilcoxon's rank-sum test (both non-parametric tests that can be used with skewed data) to identify significant differences in fluxes among the four topographic position – crop type combinations. Finally, we removed outliers from the dataset and constructed a least-squares linear regression model from the remaining data. No log-transformation of the data was performed.

Results:

Fluxes (fig. 3A): Chamber N_2O fluxes for the study period ranged from -9.8 to 21.3 μg N_2O-N m^{-2} hr^{-1} except for one observation of 77.6 μg N_2O-N m^{-2} hr^{-1} at chamber 2 at the low topographic position with RCG of plot B (BLT-2) on April 4th. Exploratory data analysis showed

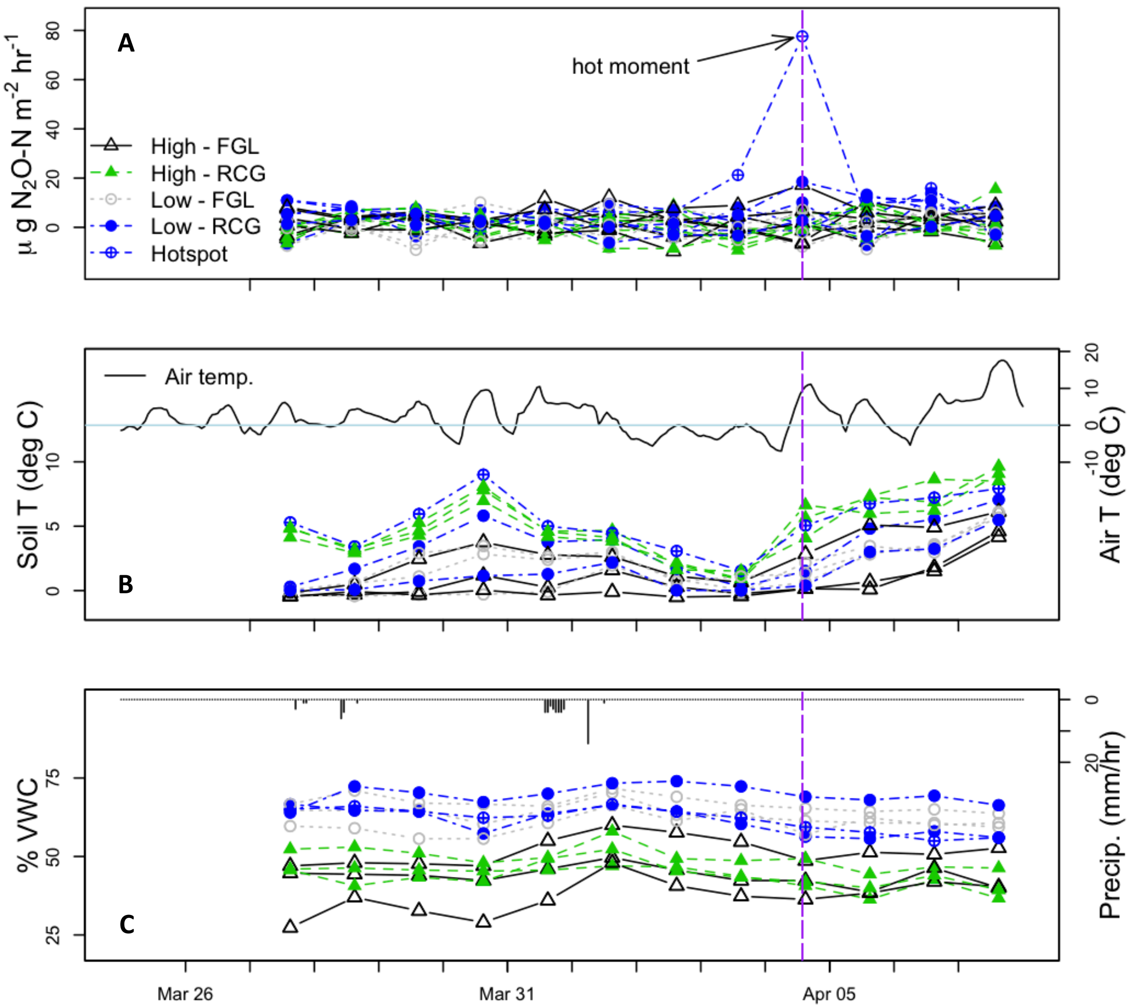


Figure 3: Daily fluxes for each treatment with the hot-moment indicated by an arrow (A), air temperature and soil temperature for each treatment (B), precipitation (mm/hr) and soil water content (% VWC) for each treatment (C) over the full course of the study. The hotspot is indicated by open circles with a cross. High indicates the high topographic position, Low indicates the low topographic position. FGL indicates fallow grassland, RCG indicates reed canarygrass.

that the distribution of fluxes was positively skewed and marked by this outlier.

Temperature (fig. 3B): The record of hourly mean air temperature at the site shows a diurnal cycle with significant day-to-day variation. A multi-day cold spell beginning on April 1st and lasting till April 4th drove soil temperatures downward. This trend was followed by an abrupt change to warmer weather, and the soil temperatures at all subplots rose. Daily maximum soil temperatures across subplots ranged from -0.5 to 9.6°C with clear differences in trends between subplots, most notably between the RCG and FGL subplots, the RCG generally warming to a greater degree than the FGL and more variable from day-to-day (fig. 4, 5).

Precipitation and soil moisture (fig 3C): All snowcover had melted by the beginning of the study period, but some soil at the site remained frozen during the study; by the final observations on April 7th almost all subplots had completely thawed. Light to moderate precipitation occurred during the first half of the observation period. The precipitation affected soil moisture immediately, with some decrease evident during the drier second half of the observation period. There were clear differences in soil moisture between subplots which ranged from 27.4 to 74.0% VWC, the low subplots clearly wetter than the high.

Above-ground biomass (fig. 4, 5): The quantity of above-ground biomass within each chamber varied from 9.0 to 62.9 g dry biomass with differences evident between subplots in the RCG compared to those in the FGL, the RCG clearly exhibiting reduced biomass. An inverse relationship was observed between above-ground biomass and mean daily maximum soil temperature, and between above-ground biomass and the range of daily maximum soil temperature, illustrating that soil temperature is strongly influenced by the insulating nature of the biomass.

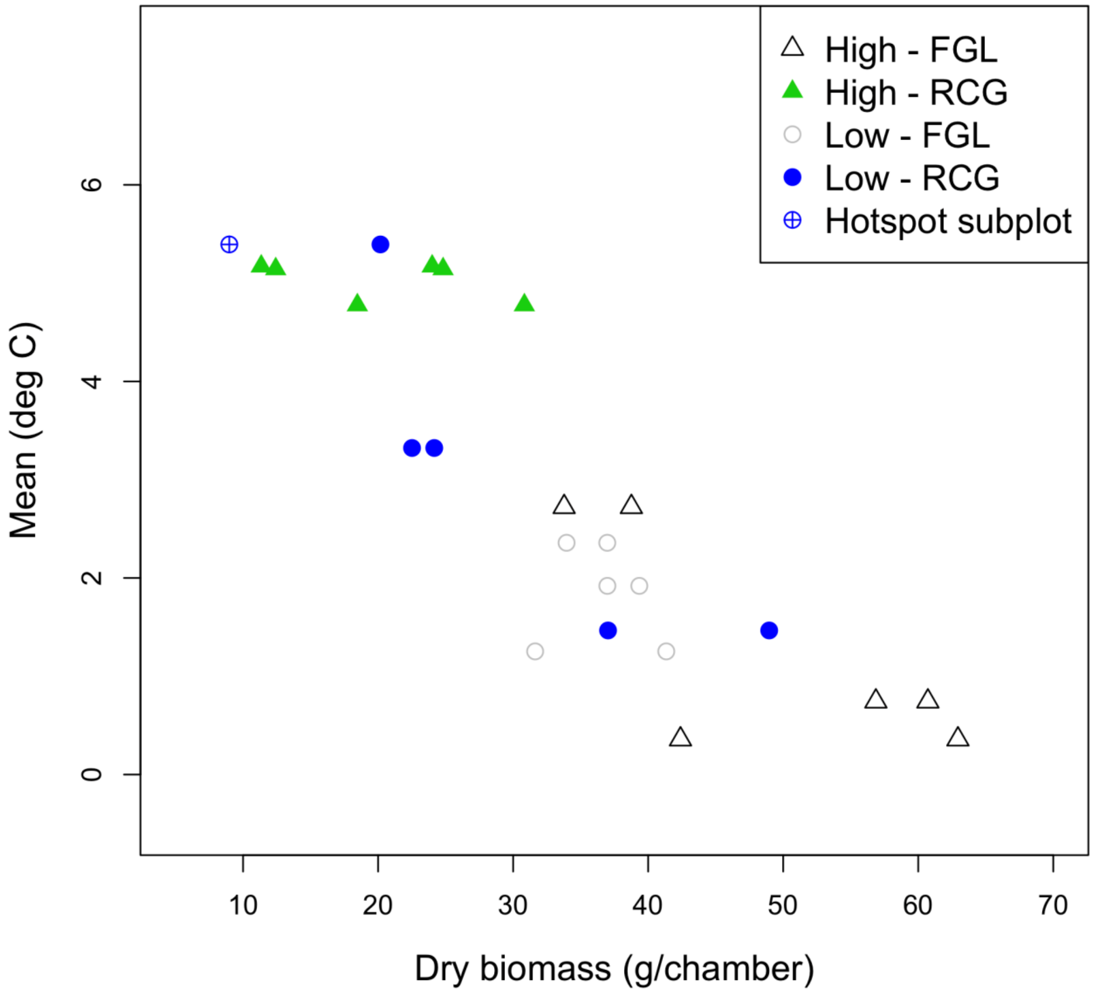


Figure 4: Relationship between quantity of above-ground biomass within each chamber (g/chamber) and mean daily maximum soil temperature (deg C) for each treatment. The hotspot subplot is indicated by an open circle with a cross. High indicates the high topographic position, Low indicates the low topographic position. FGL indicates fallow grassland, RCG indicates reed canarygrass.

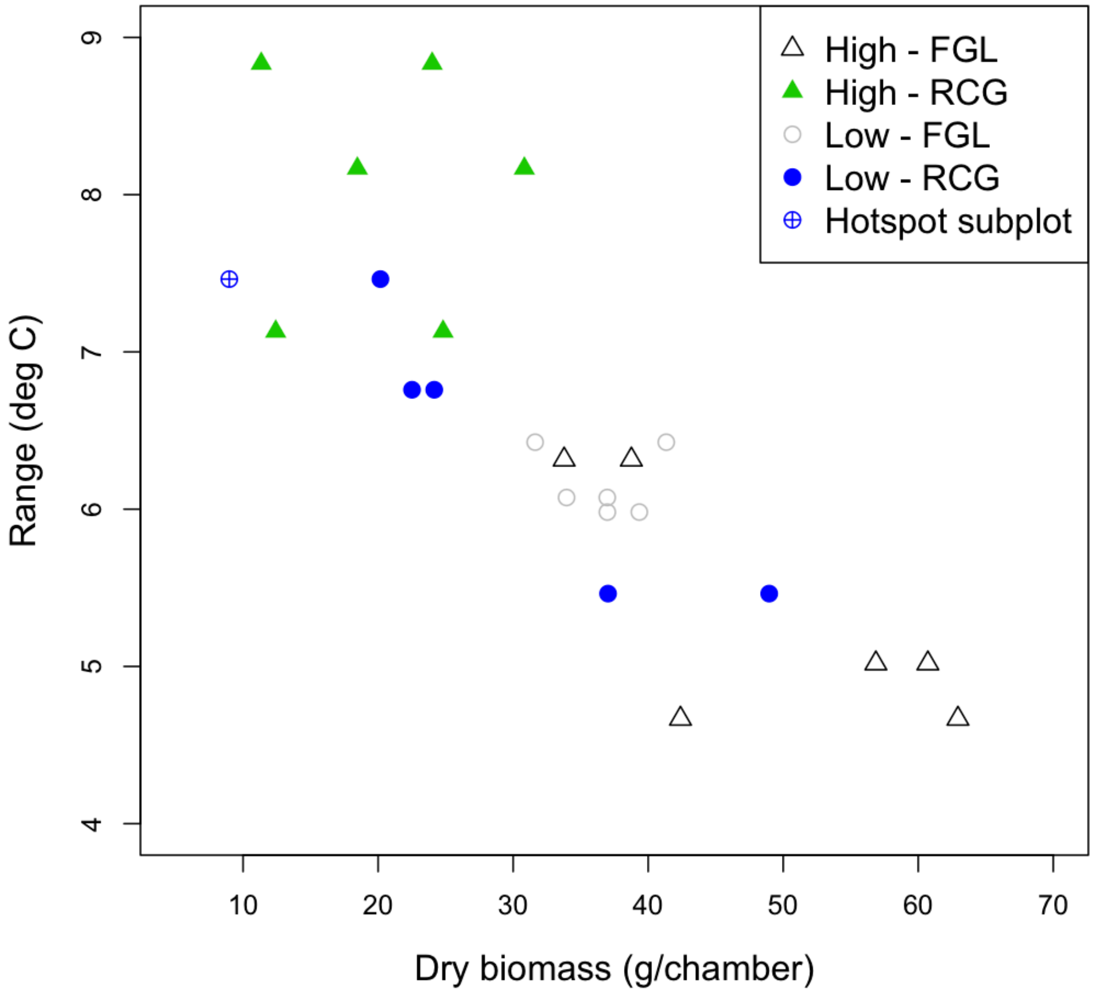


Figure 5: Relationship between quantity of above-ground biomass within each chamber (g/chamber) and range of daily maximum soil temperature (deg C) for each treatment. The hotspot subplot is indicated by an open circle with a cross. High indicates the high topographic position, Low indicates the low topographic position. FGL indicates fallow grassland, RCG indicates reed canarygrass.

Discussion:

Total N_2O emitted from all chambers during observation was 43.8 μg N_2O-N. Approximately 25% of this total, 10.7 μg N_2O-N, was from the single most active chamber, BLT-2, hereby called the hotspot. The emissions from chamber BLT-2 on April 4th, hereby called the hot-moment, were 5.1 μg N_2O-N, approximately 12% of the total from all 288 individual observations. A similar pulse of N_2O flux did not occur in the nearest chamber, BLT-1, which was located at the same subplot, 1.0 m away from BLT-2 (fig. 3A). This pattern of isolated but intense emissions is similar to the observations of Molodovskaya, Singurindy (11), Wagner-Riddle, Furon (16), Corre, vanKessel (12) and others who have reported high temporal and spatial variability of N_2O emissions from agricultural fields, and warrants special attention given to both this chambers location and micro-environment, and to the time of maximum flux.

Hotspot: The hotspot occurred at the low topographic position where soil water content was approximately 60% VWC at subplot BLT (fig. 3C). Mean daily maximum temperature of the soil at subplot BLT was the highest observed (fig. 4) and the chamber where the spike occurred contained the least above-ground biomass of all 24 chambers (fig. 4, 5). These conditions are similar to those reported in the literature for soils that produce spring-thaw pulses of N_2O. Corre, vanKessel (12) found that fluxes were higher at foot-slope positions in the landscape compared to shoulders and that differences in flux between cultivated and uncultivated land were more pronounced at the foot-slope where anoxic conditions are more prevalent. This is consistent with the position of the hotspot at BLT-2 observed during this study. It is has been observed that soil temperature is a driving factor in N_2O emissions (26). In this case, the higher temperatures observed at the hotspot confirm this relationship. In addition, the low above-ground biomass at this chamber echoes the findings of Dorsch, Palojarvi (15), Dietzel, Wolfe (23), and

Pelster, Chantigny (24) who found that reduced insulating soil cover resulted in greater N_2O emissions.

Hot-moment: The single greatest flux, 77.6 μg N_2O-N m^{-2} hr^{-1} was observed at chamber BLT-2 on April 4th. The magnitude of this flux can be compared to the results of Singurindy, Molodovskaya (17) who observed a maximum flux of 200 μg N_2O-N m^{-2} hr^{-1} during a thaw event from manure amended corn (*Zea mays* L.), and Molodovskaya, Oberg (29) who observed a maximum of 114 μg N_2O-N m^{-2} hr^{-1} from manure amended alfalfa (*Medicago sativa* L.). In our study, the maximum flux observed meets the criteria of a hot-moment, exceeding the outlier threshold which we defined as a flux observation greater than the median plus 3 times the interquartile range (12). The hot-moment threshold in this case was calculated to be 21.8 μg N_2O-N m^{-2} hr^{-1}. An elevated flux (21.3 μg N_2O-N m^{-2} hr^{-1}) nearly qualifying as a hot-moment itself, was observed at the same chamber one day earlier, suggesting sustained biological activity.

The abrupt rise in N_2O emission at the hotspot occurred at the tail end of a multi-day cooling period characterized by air temperatures that only briefly broke 0°C during the day, and settled as low as -7.2°C at night (fig. 3A, 3B). This sequence of events is similar to the findings of Wagner-Riddle, Furon (16) and Dietzel, Wolfe (23), and can be explained by reports that the magnitude of thaw induced N_2O fluxes are related to freezing intensity and duration (20) and triggered by a rapid increase in temperature (11). It is known that intensity and duration of soil freezing is related to the amount of insulating plant cover (21) and we found a similar relationship between above-ground biomass and soil temperature dynamics (fig. 5). Minimal above-ground biomass in chamber BLT-2 suggests that the soil was most susceptible to freezing and hence increased nutrient availability. We suggest that the sudden presence of newly-liberated nutrients coupled with high soil moisture at the low topographic position and daytime soil temperatures above 5°C at BLT-2 (fig. 3B) created the conditions for increased activity of denitrifying microbes and the genesis of significant amounts of N_2O on April 4th.

It is notable in our study that this observed pulse was not at the initial thaw, and that heavily insulated soils that thawed for the first time did not exhibit a pulse of N_2O. This suggests that the abruptly released N_2O constituting the hot-moment was newly generated, and that trapping of N_2O in the subsoil over a long period does not appear to be a relevant mechanism at our site. It is possible that the hot-moment was the result of either *de novo* denitrification at the time of phase change from solid to liquid water in the soil surface (0-10cm) where most N_2O production is thought to take place (21, 26), or due to generation of N_2O in anoxic water films during the freezing period that was subsequently released upon thaw, or a combination of these two mechanisms.

Statistical results: The Kruskal-Wallace rank-sum test provides evidence that there are differences among treatments ($p = 0.0002$). Applying Wilcoxon's rank-sum test to each topographic position – crop type combination against all others shows that Low - RCG is the most different ($p = 0.0001$). Wilcoxon's rank-sum test, when applied as Low - RCG against High - RCG, High - FGL, and Low - FGL individually, yields p-values of 0.0002, 0.0367, 0.0001 respectively, which were also the most significant of all (6) possible topographic position - crop type comparisons. The same pattern was observed with the application of Wilcoxon's signed-rank test using paired daily subplot flux averages to compare Low - RCG against High - RCG, High - FGL and Low - FGL with p-values of 0.0004, 0.0295, and 0.0001 respectively.

Removing the outlier from the dataset tended to slightly increase the p-values of the non-parametric statistical tests, but not significantly and did not alter the outcome of any of the non-parametric hypothesis tests. With the outlier removed, the remaining fluxes are relatively normally distributed (Shapiro-Wilks test p-value = 0.07) with only a slight positive skew (skewness = 0.28) and are suitable for parametric operations. Temporal autocorrelation was observed to be not significantly different from zero and, with no need for repeated measures analysis, a least-squares linear regression model was constructed from the data. We found that the interaction model ($p = 0.00004$) represents the data better than topographic position or crop type alone, but explains only 6.5% of the variation in flux, though this low value might be mainly due to the relatively low magnitude of emissions and a low signal to noise ratio (the greatest modeled flux was about twice the detection limit, there were 18 detects disregarding the single removed outlier). The Residual Standard Error of the model was $1.34 * 10^{-7}$ g N_2O m^{-2} min^{-1} and this value closely matches the standard deviation of simulated fluxes ($1.4 * 10^{-7}$ g N_2O m^{-2} min^{-1}) from the Monte Carlo detection limit estimation. A Least Squared Difference (LSD) test of the fluxes grouped by topographic position – crop type shows that the Low - RCG group has the highest flux and is significantly different from the other 3 groups. The average flux from the Low - RCG subplots (outlier removed) is 4.4 μg N_2O-N m^{-2} hr^{-1}, almost six times higher than for the Low - FGL. 88% of the total emissions were not classified as outliers and were included in the model, this shows that the difference between treatments is important even at low flux levels.

Both parametric and non-parametric statistical analyses confirm that the Low - RCG subplots exhibit significantly elevated N_2O fluxes compared to the other groups.

Overall, the statistical and modeling results and the hot-moment analysis indicate that elevated flux levels occurred in the Low topographic positions that were converted to RCG. As discussed in the hot-moment and hotspot analysis sections, this is likely due to the combination of reduced insulating cover (above-ground biomass) and elevated soil moisture compared to the other treatments, and these factors created conditions that are conducive to denitrification and subsequent N_2O production: Presence of organic carbon and nitrate, daytime temperatures above 5°C, and anaerobic soil conditions (see introduction). It is unlikely that a difference in nutrient availability was directly caused by residue from the previous year's fertilizer application because significant time had elapsed allowing for uptake by vegetation during the growing season, as well as by the microbial community. Additionally the species of vegetation in the FGL was largely reed canarygrass (which pre-existed at the field before conversion) and it is therefore unlikely that resident vegetation caused an increase in nutrient availability. It is possible that tillage and incorporation of organic matter during crop establishment approximately 21 months prior resulted in increased nutrient availability (SOM for example) during the study or affected the soil structure or microbial community in some other way, but we believe that the most plausible explanation is that reduced insulating capacity of the sparse grass in the partially established RCG plots (fig. 5) caused more intense and frequent freeze-thaw cycling of these soils and this created the conditions that allowed denitrification to proceed.

Conclusion:

We found that N_2O emissions over the course of this 12-day study were greatest and most frequent from the Low – RCG subplots and were comparable in magnitude, but generally lower than fluxes observed from manure amended corn and alfalfa. In the perennial grasses studied here, the Low - RCG areas sustain conditions of elevated soil moisture compared to High topographic positions and have reduced insulating plant cover (above-ground biomass) compared to the FGL, both factors that have previously been shown to be important to N_2O production and could be useful for predicting emissions at the field scale (objective iii). Our results suggest that the degree of above-ground biomass (and thus soil temperature during spring-thaw) is influenced by conversion to reed canarygrass, but it is not clear that this is the only critical element of the conversion process affecting N_2O emissions.

Ultimately, year-round observation is necessary to determine total annual N_2O losses from each treatment, but our results suggest that conversion of fallow grassland to perennial grass cropping systems for bioenergy or other uses could increase spring-thaw N_2O emissions in wetness prone areas (objective ii).

Concluding remarks and recommendations

We found that in perennial grass cropping systems during spring thaw, nitrous oxide emissions are related to landscape features and environmental conditions. This is not surprising and has been found to be the case in other studies, but here we confirm that the primary mechanisms and controlling factors in other situations during spring thaw seem to also be relevant in perennial grasses. The results of this study strengthen the previous research that it confirms. It also provides some information about the potential impact of using fallow land for bioenergy production and suggests ways that nitrous oxide emissions could be mitigated in a land conversion scenario.

There are still aspects of nitrous oxide production in soils at spring thaw that are not understood. Specifically, these seem to be dynamics of microbial populations under freeze-thaw conditions, the exact physical and biological mechanisms of nutrient liberation during thaw events, and the effect of variation within the plant-soil continuum and its atmospheric interface on the generation and transmission on nitrous oxide.

It was noted during the observation period that the chamber collars that were installed prior to the study and left in place throughout seemed to have an effect on the conditions within. Most notably, the collars seemed to shade the enclosed area and caused the temperatures to be cooler than the surrounding areas which were more exposed to sunlight and surface air currents. These effects could affect the outcome of an experiment if the actual conditions within the chamber are not accounted for. It would be a worthwhile advance to adopt a less intrusive chamber design in this regard.

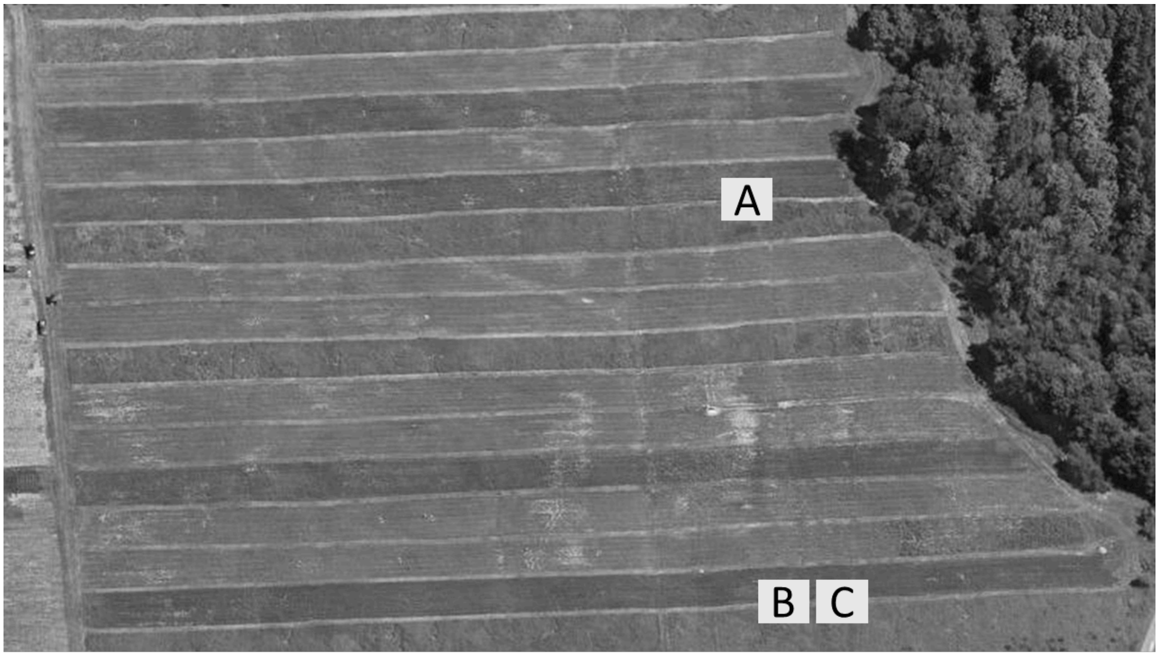
It was also noted during the study that significant heterogeneity existed in the soil and plant arrangement, both within subplots and within single chambers themselves. It is possible that nitrous oxide emissions detected with a single chamber are due to genesis in only a portion of the soil, a microsite, enclosed by the chamber. Thus, characterizing an emission observation based on the general characterization of the chamber location or conditions may overlook the actual conditions of nitrous oxide genesis. A study on the effect of the degree of surface soil topographic variability on emissions may provide insight on this front.

We saw that when emissions occurred they tended to be sudden, sporadic, and short-lived and this has been the trend in other studies. This suggests that the microbial action that results in nitrous oxide production may change on a temporal scale of hours or even minutes. The change in phase of water between liquid and solid also takes place at short time scales, and we suggest that a higher frequency of observation is appropriate to further investigate the dynamics of the processes and factors involved.

To summarize, additional research should look in finer detail at temporal fluctuations in soil temperature, and asess the effect of small-scale heterogeneity of soil conditions with respect to proximity to plants, micro-topography, and atmospheric exposure. Microbial community analysis may also prove useful in elucidating the mechanisms at play in nitrous oxide formation, and if chambers are used in the field, an improved design or temperature and moisture monitoring scheme employed.

APPENDIX

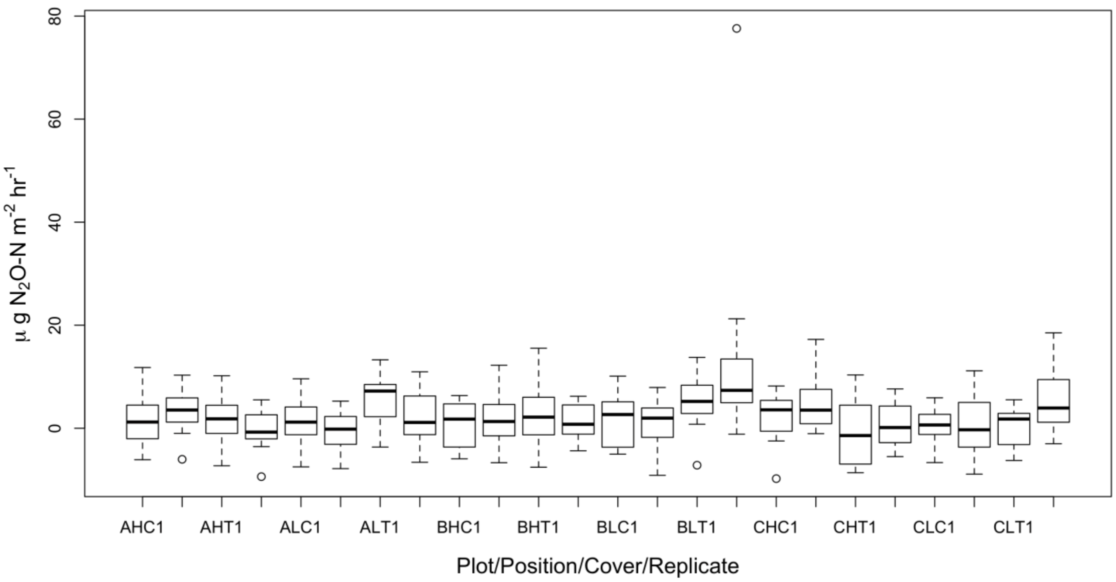
Supplementary Images



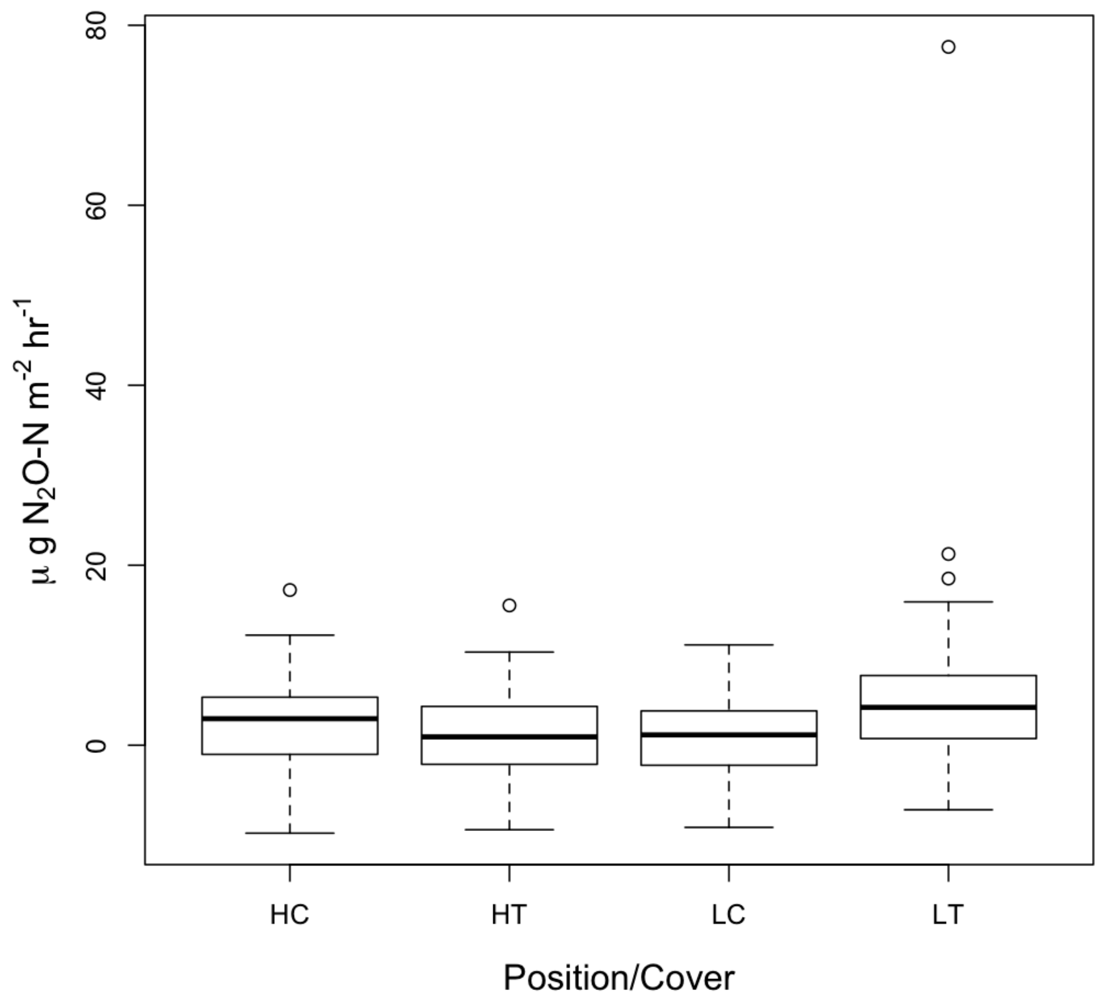
Supplementary image 1: Aerial view of field site and plot arrangement. Map data: © 2013 Google

Supplementary image 2: Photographs of fallow grassland (FGL) (top), and reed canarygrass (RCG) (bottom) at plot A, taken on April 3rd, 2014 one year after the study. These images indicate the approximate state of the site during the study.

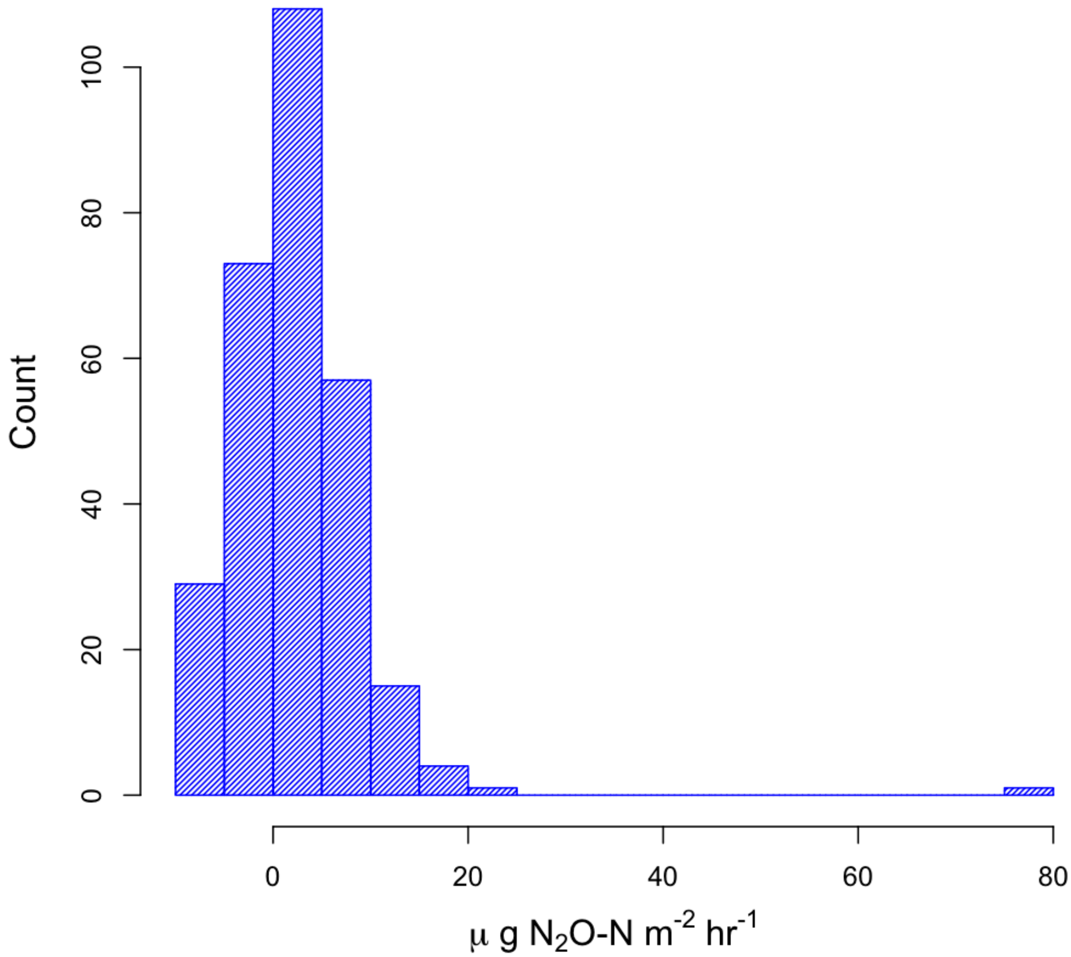
Supplementary image 3: Photographs of fallow grassland (FGL) (top), and reed canarygrass (RCG) (bottom) at plot C, taken on April 3rd, 2014 one year after the study. These images indicate the approximate state of the site during the study.



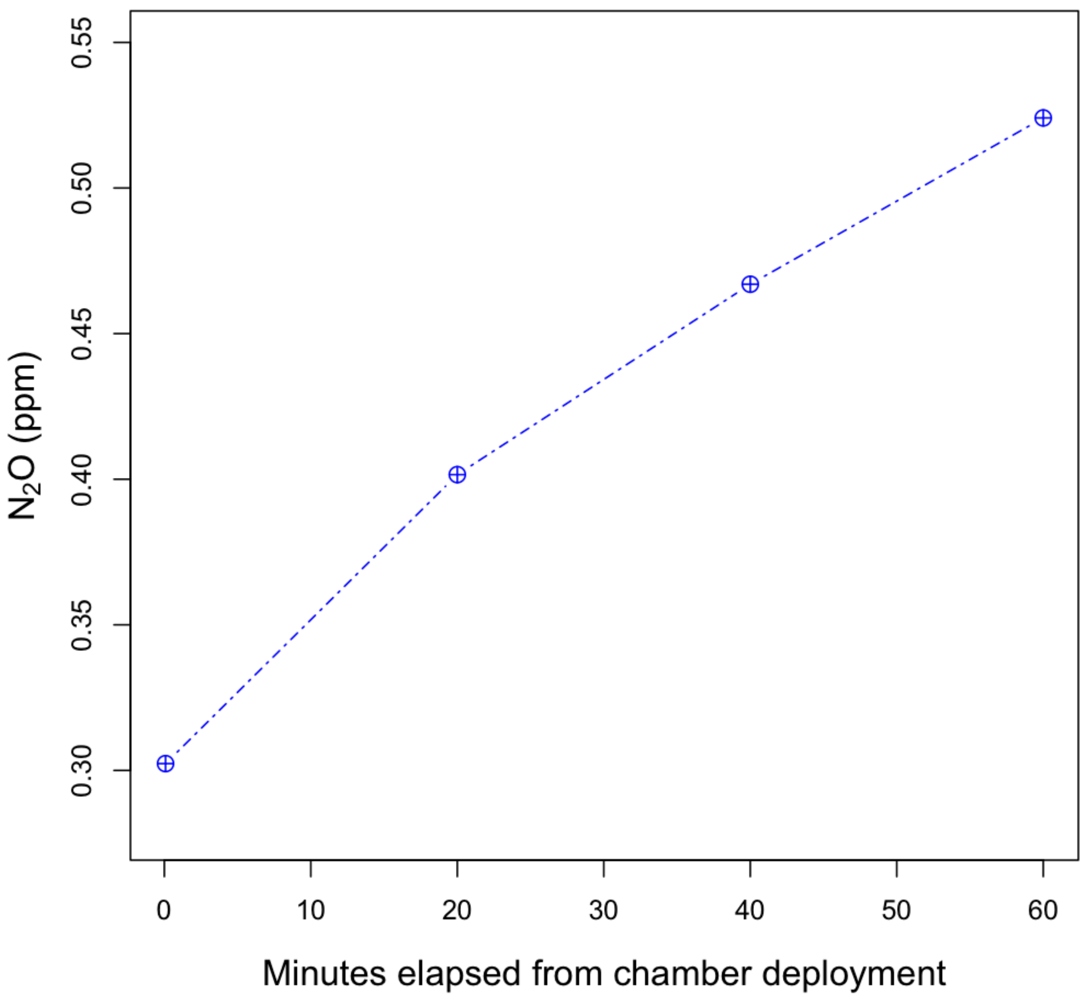
Supplementary image 4: Boxplots of N_2O flux for each chamber. The first label digit indicates the plot (A, B or C), the second indicates the topographic position (High or Low), the third indicates fallow grassland (C) or reed canarygrass (T), the fourth indicates the replicate number (1 or 2). Unlabeled boxes are the second replicate (2) of the box immediately to the left.



Supplementary image 5: Boxplots of N_2O fluxes for each topographic position – crop type combination. The first digit of each box label indicates high or low topographic position (H or L), the second indicates fallow grassland (C) or reed canarygrass (T).



Supplementary image 6: Histogram of all N_2O fluxes.



Supplementary image 7: Plot of chamber deployment time vs. chamber concentration of N_2O for hot-moment flux observation at chamber BLT-2 on April 4th, 2013.

Protocol for sample collection and analysis

The procedures undertaken for the acquisition of data from the study site can be divided into four stages: Preparation, sample collection, storage, and analysis.

1. Preparation

Vial preparation: The vials are first left uncapped in the open air for at least 30 minutes to allow any previous contents to diffuse. The vials are then fitted with an un-used butyl rubber stopper and capped with an aluminum ring crimped by the “Crimpenstein” device, or the hand held crimper (lab crimper #2). The “Crimpenstein” crimping pressure is set to one less that the middle setting (one green and one yellow light), the hand held crimper is set to the tightest setting. After capping is complete the vials are randomized before evacuation.

The vials are evacuated the morning of the sampling campaign. Each vial is evacuated for 30 seconds at -90 kPa using a large (21 gage) needle, changed every 60 vials. Evacuate all vials in a single session and use a rotation technique, employing the white shut off valves to start and stop the evacuation of each vial. When removing an evacuated vial, pull smoothly straight off the needle at a steady pace, not too fast or too slow. The rate at which a vial is pulled from the needle impacts the leakage from the surrounding air back into the vial as it is removed, greatly affecting the quality of the vacuum. Randomize all vials by gently mixing them in a cardboard box or plastic bucket prior to evacuation.

The evacuated vials are arranged in trays and pre-labeled with the chamber and time of sample injection. Spare vials and calibration vials were bagged, stored and transported along with the sample vials.

Field/lab prep:

Calibrations were prepared in gas bags in the lab at these mixing ratios:

N2O conc	N2O 1 ppm volume	CH4 conc	Std mix volume	O2 conc	O2 volume
0.33 ppm	333 mL	9.34 ppm	467 mL	20%	200 mL
0.5	500	6	300	20%	200
0.8	800	0	0	20%	200

Sampling kits were assembled in the lab ahead of the sampling campaign. New needles were included and installed on the syringe in the field. Chamber covers were laid out next to each collar just before the chamber sampling. Before each campaign, the rubber seals on the chamber collars were checked and vegetation moved away from the collar as necessary to allow for proper chamber cover placement.

2. Sample Collection

Vial injection: Chamber observations occurred simultaneously at all three transects, with one sampler running a rotating sampling schedule around the transect. For each chamber, the cover was placed over the collar at t=0:00 and the first sample taken from the chamber at t = 0:05. Subsequent samples were taken at t=20:00, 40:00 and 60:00. Air samples were taken from the chamber by inserting an empty syringe and needle assembly through the rubber septum in the chamber cover. 20ml of air was drawn into the syringe at the appropriate time. The syringe needle was left in the septum for an additional 2 to 3 seconds after the plunger was extended, long enough to allow the pressure to equilibrate between the chamber and the syringe, filling the syringe. The syringe and needle assembly was then withdrawn from the chamber, and the plunger was set to 15 ml. Immediately the needle was inserted into the appropriate vial through its septum. The syringe plunger was monitored as the vacuum in the vial sucked the sample down into the vial. In cases where the plunger was pulled less than 5 ml, it was assumed that the vial had lost its vacuum, and a second withdrawal from the chamber and injection into a spare vial was made, with a note of the adjusted time. After it was verified that the plunger had been pulled at least 5 ml, the full remaining volume in the syringe was pushed into the vial by completely depressing the plunger and the syringe needle was withdrawn from the vials septum. Upon completing the sampling schedule, we recorded any notes or adjustments.

Soil moisture and temperature: Immediately after the chamber sampling was completed, we observed and recorded soil moisture and temperature at each sampling location. We took three moisture and temperature measurements at each subplot using thermometers and the TDR unit. The TDR and thermometers were generally placed between the two chamber bases, or to the outside of the pair with care being taken to avoid trampled or disrupted areas.

3. Sample Storage

Calibration samples: Immediately after sampling and environmental observations were completed, the calibration vials were injected with the prepared mixes in the same manner as the field samples, labeled and stored in a zip-loc bag.

Storage: All field samples and calibration samples were stored in zip-loc bags within a cardboard box on a shelf in the lab at room temperature until analysis.

4. Sample Analysis

Analysis: Just prior to analysis with the gas chromatograph (GC), all field samples and check samples were vented to room pressure by inserting a bare syringe needle through the septum for about 1 or 2 seconds. In most cases, the excess pressure could be heard escaping the vial with a "pshh" sound, indicating that there was still some overpressure in the vial despite the storage time. Each batch of GC analysis was accompanied by calibration samples at three different concentrations.

Field and lab log

3/25/2013: Installed pairs of high and low slope positions in both RC and control plots for 3 slopes. Intent was to capture different freezing patterns. Locations were chosen based on apparent wetness or dryness. Low positions were chosen to be near (approximately 2 feet from) standing water in ditches. High positions were chosen based on what appeared to be the driest areas. Soil was mostly frozen. Control soil was almost always frozen, except appeared to be muddy/less frozen very close to standing water. Lower areas in control tended to have uneven frozen ice/mud under the grass, but still solid for the most part. Control high areas tended to be frozen solid as well, but less muddy, all control locations chosen were covered with a good degree of bent-over dead grass. In RC plots, soil seemed less frozen, even thawed in some locations, but also frozen in others. Some locations in RC have a decent layer of dead grass/mulch left from fall mowing while others are much more exposed. Collars were installed by cutting a circle with scissors and removing all easily removed dead grass with as little disturbance as possible and setting dead/dry grass aside. A circular groove was then cut with the saw, this was very difficult and took about 15 minutes per collar. Loose soil frozen and thawed was set aside in a plastic dish, the collar was set into groove and removed soil pressed around outside of collar/soil junction. Disturbed soil inside collar was gently smoothed around the inner edge but not compacted. Dried grass that had been cut was replaced inside the collar. Grass from around the periphery was re-arranged to cover the exposed and compacted area around the outside of the collar so that the layer of insulation was more or less like the surrounding area and no soil was left exposed due to the installation. In a few cases, nearby grass was gathered and placed around the outside of the collar to approximate the surface cover of the immediate area.
4/8/2013: Completed final run yesterday, 12 in total. There was a good sequence of freezing and thawing during sampling period. Large heterogeneity was observed with respect to ice/soil temps

inside vs. outside chamber collars, likely due to shading and shielding of soil within chamber. Outside of the collars, I observed large variations in topography, vegetation and soil within the controls, not as much within the treatment, but still somewhat. I conclude that larger chambers would reduce this shielding effect and overcome variation of the surface, and reduce impact of disturbance around collar seat. Also, lower/shorter chambers would be appropriate for this study because there is no standing grass in either control or treatment.

Worked to improve the GC method with success. Essentially, lowering oven temp and extending inlet purge time. New run is longer, but with ~10x sensitivity. Final Method: NOME_20.M

Biomass was collected in wet conditions and stored in sealed Ziploc bags in lab till 4/24/2013. I measured total wet mass for each subplot, and pulled a subsample of around 15 g into an aluminum pan. I dried all subplots at once overnight. I weighed dry mass immediately.

5/10/2013: last few days began processing and looking at FT data, first 5 runs. Concentrations look good, and less noisy than older transect runs. Did some preliminary looking at slopes, mostly near zero. Entered soil moisture and temp data into csv files. Now preparing to assemble model and will add remaining flux data when analyzed.

5/31/2013: Looked at recent data and saw a big flux with probable multi-day pattern. Processing raw data by integrating with NOME_20 method on laptop.

Data

All original data is provided in comma separated value (csv) format. Some of the data can be used with the provided R scripts to repeat the procedures described in the paper. Brief descriptions of the data heading, and relevance to R scripts is given before each data set.

Raw gas chromatography data

This data provides the results of the gas chromatography analysis for all field samples and calibrations. It can be processed with script 1 to calculate the chamber fluxes.

Header description:

- *"original sequence": Name of original GC sequence.*
- *"samplename": Name of sample or calibration.*
- *"correcttime": Indicates the time of sample collection corrected for late sampling. Blank for calibrations.*
- *"samplecomment": Indicates additional information about the sample. Check samples are indicated by "CHK", calibrations are indicated by "CAL".*
- *"extra_field": Used to mark samples for rejection.*
- *"ECDtime1": Elution time of detected peak.*
- *"ECDarea1": Peak area of integrated N_2O peak.*
- *"collectdate": Date of sample collection.*

```
originalsequence,samplename,correcttime,samplecomment,extra_field,ECDtime1,ECDarea1,collectdate
FT327A,CHK N2O,,CHK,ok,3.970731974,167.2140045,20130327
FT327A,CHK CH4,,CHK,ok,0,0,20130327
FT327A,0.33,,CAL,ok,3.960399628,57.36125183,20130327
FT327A,0.5,,CAL,ok,3.958878517,78.71360779,20130327
FT327A,0.8,,CAL,ok,3.96619463,123.6047897,20130327
FT327A,AHT-1-1,0.083,,ok,3.971902847,53.51281357,20130327
FT327A,AHT-1-2,20,,ok,3.971629143,51.09140396,20130327
FT327A,AHT-1-3,40,,ok,3.974964619,52.66786575,20130327
FT327A,AHT-1-4,60,,ok,3.958907604,52.4852829,20130327
FT327A,AHT-2-1,0.083,,ok,3.98067975,53.22708893,20130327
FT327A,AHT-2-2,20,,ok,3.967845917,53.01265335,20130327
FT327A,AHT-2-3,40,,ok,3.983407259,53.08145142,20130327
FT327A,AHT-2-4,60,,ok,3.977872372,53.85335541,20130327
FT327A,AHC-1-1,0.083,,ok,3.976490974,54.51760864,20130327
FT327A,AHC-1-2,20,,ok,3.969530582,52.41615295,20130327
FT327A,AHC-1-3,40,,ok,3.975613832,52.95127106,20130327
FT327A,AHC-1-4,60,,ok,3.975936174,52.8266449,20130327
FT327A,AHC-2-1,0.083,,ok,3.974927902,52.43826675,20130327
FT327A,AHC-2-2,20,,ok,3.981306076,51.16291809,20130327
FT327A,AHC-2-3,40,,ok,3.969709158,52.44821548,20130327
FT327A,AHC-2-4,60,,ok,3.963451862,55.26354599,20130327
FT327A,ALT-1-1,0.083,,ok,3.966583252,52.33879471,20130327
FT327A,ALT-1-2,20,,ok,4.000487328,51.42990875,20130327
```

FT327A,ALT-1-3,40,,ok,3.978630781,55.61791992,20130327
FT327A,ALT-1-4,60,,ok,3.968482256,55.70862579,20130327
FT327A,ALT-2-1,0.083,,ok,3.972119093,55.54246521,20130327
FT327A,ALT-2-2,20,,ok,3.970816135,54.29916,20130327
FT327A,ALT-2-3,40,,ok,3.969118595,53.39398575,20130327
FT327A,ALT-2-4,60,,ok,3.974565506,52.98865128,20130327
FT327A,ALC-1-1,0.083,,ok,3.971700191,53.54458618,20130327
FT327A,ALC-1-2,20,,ok,3.974638462,55.80791855,20130327
FT327A,ALC-1-3,40,,REJY,0,0,20130327
FT327A,ALC-1-4,60,,ok,3.975210667,51.27837372,20130327
FT327A,ALC-2-1,0.083,,ok,3.98026824,51.4416008,20130327
FT327A,ALC-2-2,20,,ok,3.971793652,50.85322952,20130327
FT327A,ALC-2-3,40,,ok,3.97550416,52.74202728,20130327
FT327A,ALC-2-4,60,,ok,3.977570534,51.59329224,20130327
FT327A,0.33,,CAL,ok,3.976760387,57.65929794,20130327
FT327A,0.5,,CAL,ok,3.97160697,80.28799438,20130327
FT327A,0.8,,CAL,ok,3.976761103,120.3372574,20130327
FT327B,CHK N2O,,CHK,ok,3.98030591,135.5714111,20130327
FT327B,CHK CH4,,CHK,ok,0,0,20130327
FT327B,0.33,,CAL,ok,3.970308304,51.80348206,20130327
FT327B,0.5,,CAL,ok,3.973610878,77.40066528,20130327
FT327B,0.8,,CAL,ok,3.96391511,121.2570953,20130327
FT327B,BHT-1-1,0.083,,ok,3.96832943,53.34095001,20130327
FT327B,BHT-1-2,20,,ok,3.962455988,54.29162216,20130327
FT327B,BHT-1-3,40,,ok,3.963762283,53.11197281,20130327
FT327B,BHT-1-4,60,,ok,3.959732294,54.43167114,20130327
FT327B,BHT-2-1,0.083,,ok,3.96816659,56.08406448,20130327
FT327B,BHT-2-2,20,,ok,3.956744909,52.81659317,20130327
FT327B,BHT-2-3,40,,ok,3.961060524,52.31951523,20130327
FT327B,BHT-2-4,60,,ok,3.957917929,54.24631119,20130327
FT327B,BHC-1-1,0.083,,ok,3.940406561,54.11580658,20130327
FT327B,BHC-1-2,20,,ok,3.957585096,53.59827805,20130327
FT327B,BHC-1-3,40,,ok,3.962719202,53.30155182,20130327
FT327B,BHC-1-4,60,,ok,3.962480783,52.16489029,20130327
FT327B,BHC-2-1,0.083,,ok,3.969138622,55.56918335,20130327
FT327B,BHC-2-2,20,,ok,3.959348917,54.13369751,20130327
FT327B,BHC-2-3,40,,ok,3.96075201,53.97688293,20130327
FT327B,BHC-2-4,60,,ok,3.956790209,55.94604492,20130327
FT327B,BLT-1-1,0.083,,ok,3.959851027,53.66500092,20130327
FT327B,BLT-1-2,20.333,+ 0:20,ok,3.960134506,56.2095871,20130327
FT327B,BLT-1-3,40,,ok,3.964289904,56.08739853,20130327
FT327B,BLT-1-4,60,,ok,3.953062534,56.17507553,20130327
FT327B,BLT-2-1,0.083,,ok,3.962203026,54.31339264,20130327
FT327B,BLT-2-2,20,,ok,3.965116024,57.56833649,20130327
FT327B,BLT-2-3,40,,ok,3.95425415,56.92320251,20130327
FT327B,BLT-2-4,60,,ok,3.959315777,59.5431633,20130327
FT327B,BLC-1-1,0.083,,ok,3.9617939,53.98635864,20130327
FT327B,BLC-1-2,20,,ok,3.964683056,53.77565384,20130327
FT327B,BLC-1-3,40,,ok,3.96872282,55.44818115,20130327
FT327B,BLC-1-4,60,,ok,3.960253,54.59164429,20130327
FT327B,BLC-2-1,0.083,,ok,3.963657379,54.42951584,20130327
FT327B,BLC-2-2,20,,ok,3.961650848,53.92702103,20130327
FT327B,BLC-2-3,40,,ok,3.966666698,54.48791885,20130327
FT327B,BLC-2-4,60,,ok,3.972110748,55.50250244,20130327
FT327B,0.33,,CAL,ok,3.958433867,60.75750351,20130327
FT327B,0.5,,CAL,ok,3.965506315,84.47966003,20130327
FT327B,0.8,,CAL,ok,3.962443113,126.4454956,20130327
FT327C,CHK N2O,,CHK,ok,3.963913918,163.9985657,20130327
FT327C,CHK CH4,,CHK,ok,0,0,20130327
FT327C,0.33,,CAL,ok,3.970066071,57.73060989,20130327
FT327C,0.5,,CAL,ok,3.967168808,80.46179199,20130327
FT327C,0.8,,CAL,ok,3.970754385,120.4914627,20130327

FT327C,CHT-1-1,0.083,,ok,3.967582464,54.77114868,20130327
FT327C,CHT-1-2,20,,ok,3.964737892,54.16102982,20130327
FT327C,CHT-1-3,40,,ok,3.962727308,52.67896271,20130327
FT327C,CHT-1-4,60,,ok,3.968523026,52.54541779,20130327
FT327C,CHT-2-1,0.083,,ok,3.97430706,53.11771011,20130327
FT327C,CHT-2-2,20,,ok,3.960325956,57.24021149,20130327
FT327C,CHT-2-3,40,,ok,3.976623774,52.56448364,20130327
FT327C,CHT-2-4,60,,ok,3.962553024,54.55934525,20130327
FT327C,CHC-1-1,0.083,,ok,3.968956232,52.95646286,20130327
FT327C,CHC-1-2,20,,ok,3.971889257,56.11936569,20130327
FT327C,CHC-1-3,40,,ok,3.965008736,55.15065765,20130327
FT327C,CHC-1-4,60,,ok,3.972849131,56.71458817,20130327
FT327C,CHC-2-1,0.083,,ok,3.962083101,53.53916931,20130327
FT327C,CHC-2-2,20,,ok,3.974432945,54.53812408,20130327
FT327C,CHC-2-3,40,,ok,3.965053082,55.88645935,20130327
FT327C,CHC-2-4,60,,ok,3.970697165,54.70532608,20130327
FT327C,CLT-1-1,0.083,,ok,3.970736265,54.51268005,20130327
FT327C,CLT-1-2,20,,ok,3.957896948,56.85287857,20130327
FT327C,CLT-1-3,40,,ok,3.96849227,56.82208633,20130327
FT327C,CLT-1-4,60,,ok,3.963346958,55.09156418,20130327
FT327C,CLT-2-1,0.083,,ok,3.965194464,55.78916931,20130327
FT327C,CLT-2-2,20,,ok,3.96607089,54.83179092,20130327
FT327C,CLT-2-3,40,,ok,3.95980835,57.09583664,20130327
FT327C,CLT-2-4,60,,ok,3.966832161,57.25805664,20130327
FT327C,CLC-1-1,0.083,,ok,3.969186068,54.95385742,20130327
FT327C,CLC-1-2,20,,ok,3.973465681,55.66394043,20130327
FT327C,CLC-1-3,40,,ok,3.961643457,53.80107117,20130327
FT327C,CLC-1-4,60,,ok,3.970160007,55.4564743,20130327
FT327C,CLC-2-1,0.083,,ok,3.96420002,54.00286102,20130327
FT327C,CLC-2-2,20,,ok,3.974312305,54.65877151,20130327
FT327C,CLC-2-3,40,,ok,3.976802588,56.25740051,20130327
FT327C,CLC-2-4,60,,ok,3.973136187,54.67271042,20130327
FT328A,CHK N2O,,CHK,ok,3.967114687,158.7456055,20130328
FT328A,CHK CH4,,CHK,ok,0,0,20130328
FT328A,0.33,,CAL,ok,3.975445986,54.86491013,20130328
FT328A,0.5,,CAL,ok,3.971557856,77.50354767,20130328
FT328A,0.8,,CAL,ok,3.975980282,114.947197,20130328
FT328A,AHT-1-1,0.083,,ok,3.978447199,50.1476059,20130328
FT328A,AHT-1-2,20,,ok,3.974063396,50.34864426,20130328
FT328A,AHT-1-3,40,,ok,3.975277185,49.20370102,20130328
FT328A,AHT-1-4,60.75,0:45 late,ok,3.976250648,52.15956116,20130328
FT328A,AHT-2-1,0.083,,ok,3.971764565,51.03327942,20130328
FT328A,AHT-2-2,20,,ok,3.97931695,50.09979248,20130328
FT328A,AHT-2-3,40,,ok,3.982521057,50.63043976,20130328
FT328A,AHT-2-4,60,slow,ok,3.976874828,49.79302216,20130328
FT328A,AHC-1-1,0.083,,ok,3.967325211,50.08825302,20130328
FT328A,AHC-1-2,20,,ok,3.970941305,49.33850861,20130328
FT328A,AHC-1-3,40,,ok,3.982625008,52.00367355,20130328
FT328A,AHC-1-4,60,,ok,3.97315836,51.10375214,20130328
FT328A,AHC-2-1,0.083,,ok,3.980416059,50.55518723,20130328
FT328A,AHC-2-2,20,,ok,3.974434614,51.85458755,20130328
FT328A,AHC-2-3,40,,ok,3.9814744,51.20118332,20130328
FT328A,AHC-2-4,60,,ok,3.967550039,51.94852066,20130328
FT328A,ALT-1-1,0.083,,ok,3.975543022,51.82276917,20130328
FT328A,ALT-1-2,20,,ok,3.975530386,50.33929062,20130328
FT328A,ALT-1-3,40,,ok,3.978387594,52.95446014,20130328
FT328A,ALT-1-4,60,,ok,3.979177713,54.35530853,20130328
FT328A,ALT-2-1,0.083,,ok,3.972378731,51.57249451,20130328
FT328A,ALT-2-2,20,,ok,3.977852821,52.31540298,20130328
FT328A,ALT-2-3,40,,ok,3.97471261,51.57381058,20130328
FT328A,ALT-2-4,60,,ok,3.975127459,52.81726456,20130328
FT328A,ALC-1-1,0.083,,ok,3.98351264,52.09755325,20130328

FT328A,ALC-1-2,20,,ok,3.967791319,51.57941437,20130328
FT328A,ALC-1-3,40,,ok,3.977016926,54.7064209,20130328
FT328A,ALC-1-4,60,,ok,3.981755733,51.56694031,20130328
FT328A,ALC-2-1,0.083,,ok,3.976115227,52.17127991,20130328
FT328A,ALC-2-2,20,,ok,3.979936361,51.05797195,20130328
FT328A,ALC-2-3,40,,ok,3.972672224,52.414711,20130328
FT328A,ALC-2-4,60,,ok,3.978627443,52.54620743,20130328
FT328A,0.33,,CAL,ok,3.980567217,56.80707169,20130328
FT328A,0.5,,CAL,ok,3.978261948,79.93909454,20130328
FT328A,0.8,,CAL,ok,3.981019974,117.7700806,20130328
FT328B,CHK N2O,,CHK,ok,3.978484392,163.5304108,20130328
FT328B,CHK CH4,,CHK,ok,0,0,20130328
FT328B,0.33,,CAL,ok,3.982535124,56.53661346,20130328
FT328B,0.5,,CAL,ok,3.978957415,78.94000244,20130328
FT328B,0.8,,CAL,ok,3.986070156,120.6355667,20130328
FT328B,BHT-1-1,0.083,,ok,3.979878187,50.53888321,20130328
FT328B,BHT-1-2,20,,ok,3.983496666,51.91397095,20130328
FT328B,BHT-1-3,40,,ok,3.98286128,53.82427216,20130328
FT328B,BHT-1-4,60,,ok,3.983495474,51.64510727,20130328
FT328B,BHT-2-1,0.083,,ok,3.980934858,51.16875076,20130328
FT328B,BHT-2-2,20,,ok,3.977418423,52.96760559,20130328
FT328B,BHT-2-3,40,,ok,3.988613129,53.41708755,20130328
FT328B,BHT-2-4,60,,ok,3.983347893,52.95973206,20130328
FT328B,BHC-1-1,0.083,,ok,3.979733229,51.56473923,20130328
FT328B,BHC-1-2,20,,ok,3.974645615,53.02633667,20130328
FT328B,BHC-1-3,40,,ok,3.983164549,52.93621445,20130328
FT328B,BHC-1-4,60,,ok,3.987518787,53.35345078,20130328
FT328B,BHC-2-1,0.083,,ok,3.975129366,53.35045242,20130328
FT328B,BHC-2-2,20,,ok,3.981559277,51.3431015,20130328
FT328B,BHC-2-3,40,,ok,3.99557066,51.77090836,20130328
FT328B,BHC-2-4,60,,ok,3.98273468,52.21981049,20130328
FT328B,BLT-1-1,0.083,,ok,3.973800421,52.15785217,20130328
FT328B,BLT-1-2,20,,ok,3.97888279,52.2640419,20130328
FT328B,BLT-1-3,40,,ok,3.975269556,52.79919052,20130328
FT328B,BLT-1-4,60,,ok,3.970239639,55.10271072,20130328
FT328B,BLT-2-1,0.083,,ok,3.969043016,53.75873566,20130328
FT328B,BLT-2-2,20,,ok,3.972146034,52.93768311,20130328
FT328B,BLT-2-3,40,,ok,3.968994141,55.04329681,20130328
FT328B,BLT-2-4,60,,ok,3.98166728,56.14125443,20130328
FT328B,BLC-1-1,0.083,,ok,3.974728584,51.66251373,20130328
FT328B,BLC-1-2,20,,ok,3.992848158,52.56798553,20130328
FT328B,BLC-1-3,40,,ok,3.983177185,52.87208176,20130328
FT328B,BLC-1-4,60,,ok,3.982634068,52.75379181,20130328
FT328B,BLC-2-1,0.083,,ok,3.977997303,53.26104355,20130328
FT328B,BLC-2-2,20,,ok,3.978999615,51.50344086,20130328
FT328B,BLC-2-3,40,,ok,3.993167162,51.68812943,20130328
FT328B,BLC-2-4,60,,ok,3.975737333,53.42281342,20130328
FT328B,0.33,,CAL,ok,3.981534958,56.30769348,20130328
FT328B,0.5,,CAL,ok,3.978635073,81.17479706,20130328
FT328B,0.8,,CAL,ok,3.978960991,121.9252167,20130328
,no data,,,ok,NA,NA,
FT328C,CHK N2O,,CHK,ok,3.989236355,120.2702789,20130328
FT328C,CHK CH4,,CHK,ok,0,0,20130328
FT328C,0.33,,CAL,ok,3.976008654,49.32927322,20130328
FT328C,0.5,,CAL,ok,3.971698046,70.96893311,20130328
FT328C,0.8,,CAL,ok,3.969907284,108.3379211,20130328
FT328C,CHT-1-1,0.083,,ok,3.965302706,46.37197876,20130328
FT328C,CHT-1-2,20,,ok,3.95919013,49.31644821,20130328
FT328C,CHT-1-3,40,,ok,3.964223623,49.31663132,20130328
FT328C,CHT-1-4,60,,ok,3.970383167,49.34059143,20130328
FT328C,CHT-2-1,0.083,,ok,3.962458134,49.43812943,20130328
FT328C,CHT-2-2,20,,ok,3.969000101,49.77229309,20130328

FT328C,CHT-2-3,40,,ok,3.958602905,50.30469131,20130328
FT328C,CHT-2-4,60,,ok,3.966094732,52.19848633,20130328
FT328C,CHC-1-1,0.083,,ok,3.957048178,48.9261055,20130328
FT328C,CHC-1-2,20,,ok,3.966208935,50.59284592,20130328
FT328C,CHC-1-3,40,,ok,3.972978354,50.12511063,20130328
FT328C,CHC-1-4,60,,ok,3.946751118,50.67507172,20130328
FT328C,CHC-2-1,0.083,,ok,3.952764988,52.14674759,20130328
FT328C,CHC-2-2,20,,ok,3.972319126,52.71049881,20130328
FT328C,CHC-2-3,40,,ok,3.966453791,50.18938446,20130328
FT328C,CHC-2-4,60,,ok,3.958364487,52.63604355,20130328
FT328C,CLT-1-1,0.083,,ok,3.971253633,51.66256714,20130328
FT328C,CLT-1-2,20,,ok,3.959572315,54.53358841,20130328
FT328C,CLT-1-3,40,,ok,3.999239922,51.33168793,20130328
FT328C,CLT-1-4,60,,ok,3.957736492,53.98864746,20130328
FT328C,CLT-2-1,0.083,,ok,3.955139399,51.00041962,20130328
FT328C,CLT-2-2,20,,ok,3.965916634,51.75075531,20130328
FT328C,CLT-2-3,40,,ok,3.971536398,54.41527176,20130328
FT328C,CLT-2-4,60,,ok,3.96811676,53.48674393,20130328
FT328C,CLC-1-1,0.083,,ok,3.97066617,51.78791809,20130328
FT328C,CLC-1-2,20,,ok,3.975117207,50.01924133,20130328
FT328C,CLC-1-3,40,,ok,3.960433483,49.49000168,20130328
FT328C,CLC-1-4,60,,ok,3.967869997,51.8911438,20130328
FT328C,CLC-2-1,0.083,,ok,3.968520403,53.98346329,20130328
FT328C,CLC-2-2,20,,ok,3.970170021,51.95479584,20130328
FT328C,CLC-2-3,40,,ok,3.969857454,53.48077011,20130328
FT328C,CLC-2-4,60,,ok,3.969105721,52.95656967,20130328
FT328C,0.33,,CAL,ok,3.969162941,55.5059967,20130328
FT328C,0.5,,CAL,ok,3.960157156,81.53738403,20130328
FT328C,0.8,,CAL,ok,3.964844942,121.1479416,20130328
FT329A,CHK N2O,,CHK,ok,3.972849607,152.0538635,20130329
FT329A,CHK CH4,,CHK,ok,0,0,20130329
FT329A,0.33,,CAL,ok,3.961192846,49.82382965,20130329
FT329A,0.5,,CAL,ok,3.962469578,76.14792633,20130329
FT329A,0.8,,CAL,ok,3.963919163,107.643425,20130329
FT329A,AHT-1-1,0.083,,ok,3.96687746,49.04332733,20130329
FT329A,AHT-1-2,20,,ok,3.961728334,50.31864929,20130329
FT329A,AHT-1-3,40,,ok,3.955926895,51.38729477,20130329
FT329A,AHT-1-4,60,,ok,3.973186016,49.7964592,20130329
FT329A,AHT-2-1,0.083,,ok,3.963336706,51.19958496,20130329
FT329A,AHT-2-2,20,,ok,3.965677977,52.98283005,20130329
FT329A,AHT-2-3,40,,ok,3.962002039,51.98678207,20130329
FT329A,AHT-2-4,60,,ok,3.961021423,53.7101059,20130329
FT329A,AHC-1-1,0.083,,ok,3.971798658,51.54562759,20130329
FT329A,AHC-1-2,20,,ok,3.960817575,51.00892258,20130329
FT329A,AHC-1-3,40,,ok,3.960286379,51.74312592,20130329
FT329A,AHC-1-4,60,,ok,3.960366964,53.04323578,20130329
FT329A,AHC-2-1,0.083,,ok,3.966764927,50.6391449,20130329
FT329A,AHC-2-2,20,,ok,3.965291023,50.7135849,20130329
FT329A,AHC-2-3,40,,ok,3.959486961,53.99271011,20130329
FT329A,AHC-2-4,60,,ok,3.968423843,51.52156448,20130329
FT329A,ALT-1-1,0.083,,ok,3.958257914,53.58501816,20130329
FT329A,ALT-1-2,20,,ok,3.96175766,54.63101196,20130329
FT329A,ALT-1-3,40,,ok,3.967298031,53.41043854,20130329
FT329A,ALT-1-4,60,,ok,3.964957237,52.56291962,20130329
FT329A,ALT-2-1,0.083,,ok,3.96504879,50.4908371,20130329
FT329A,ALT-2-2,20,,ok,3.971441746,52.29588318,20130329
FT329A,ALT-2-3,40,,ok,3.974298716,54.22663879,20130329
FT329A,ALT-2-4,60,,ok,3.958750725,51.92110062,20130329
FT329A,ALC-1-1,0.083,,ok,3.973690033,53.75052643,20130329
FT329A,ALC-1-2,20,,ok,3.973753691,52.1397934,20130329
FT329A,ALC-1-3,40,,ok,3.973100901,53.48065567,20130329
FT329A,ALC-1-4,60,,ok,3.957882166,52.50896072,20130329

FT329A,ALC-2-1,0.083,,ok,3.970130682,51.87875366,20130329
FT329A,ALC-2-2,20,,ok,3.960187435,52.4689827,20130329
FT329A,ALC-2-3,40,,ok,3.964220524,54.93599701,20130329
FT329A,ALC-2-4,60,,ok,3.969370604,52.30834198,20130329
FT329A,0.33,,CAL,ok,3.97063303,56.75593948,20130329
FT329A,0.5,,CAL,ok,3.965343237,77.67739868,20130329
FT329A,0.8,,CAL,ok,3.969290018,116.7570877,20130329
,no data,,,ok,NA,NA,
FT329B,CHK N2O,,CHK,ok,3.964724541,160.9418488,20130329
FT329B,CHK CH4,,CHK,ok,0,0,20130329
FT329B,0.33,,CAL,ok,3.967353344,54.37991714,20130329
FT329B,0.5,,CAL,ok,3.966184378,77.30299377,20130329
FT329B,0.8,,CAL,ok,3.968092203,114.5819855,20130329
FT329B,BHT-1-1,0.083,,ok,3.966157436,53.60343933,20130329
FT329B,BHT-1-2,20,,ok,3.966911793,53.06005859,20130329
FT329B,BHT-1-3,40,,ok,3.969561577,53.25583649,20130329
FT329B,BHT-1-4,60,,ok,3.960441828,52.89687729,20130329
FT329B,BHT-2-1,0.083,,ok,3.966357231,53.37750244,20130329
FT329B,BHT-2-2,20,,ok,3.967958689,52.52958679,20130329
FT329B,BHT-2-3,40,,ok,3.974607468,53.20031357,20130329
FT329B,BHT-2-4,60,,ok,3.96685648,53.03708649,20130329
FT329B,BHC-1-1,0.083,,ok,3.972815514,51.05021286,20130329
FT329B,BHC-1-2,20,,ok,3.965820551,52.94355392,20130329
FT329B,BHC-1-3,40,,ok,3.967781067,54.17237091,20130329
FT329B,BHC-1-4,60,,ok,3.972524643,53.23625183,20130329
FT329B,BHC-2-1,0.083,,ok,3.96559906,51.06052399,20130329
FT329B,BHC-2-2,20,,ok,3.968539953,53.83562851,20130329
FT329B,BHC-2-3,40,,ok,3.981892109,52.95914841,20130329
FT329B,BHC-2-4,60,,ok,3.971790075,53.3193779,20130329
FT329B,BLT-1-1,0.083,,ok,3.967690706,53.9608345,20130329
FT329B,BLT-1-2,20,,ok,3.938781261,53.61938095,20130329
FT329B,BLT-1-3,40,,ok,3.964341402,55.97624207,20130329
FT329B,BLT-1-4,60,,ok,3.969290972,55.21713257,20130329
FT329B,BLT-2-1,0.083,,ok,3.975692987,53.52852631,20130329
FT329B,BLT-2-2,20,,ok,3.971611977,51.89937973,20130329
FT329B,BLT-2-3,40,,ok,3.96901083,56.10708618,20130329
FT329B,BLT-2-4,60,,ok,3.96339035,55.21260834,20130329
FT329B,BLC-1-1,0.083,,ok,3.975429773,53.86722946,20130329
FT329B,BLC-1-2,20,,ok,3.968599081,54.22333527,20130329
FT329B,BLC-1-3,40,,ok,3.965066671,54.45817566,20130329
FT329B,BLC-1-4,60,,ok,3.9674716,55.80741119,20130329
FT329B,BLC-2-1,0.083,,ok,3.971382856,55.91260529,20130329
FT329B,BLC-2-2,20,,ok,3.984811068,53.10265732,20130329
FT329B,BLC-2-3,40,,ok,3.96496129,52.66025543,20130329
FT329B,BLC-2-4,60,,ok,3.961605072,52.3261261,20130329
FT329B,0.33,,CAL,ok,3.967253447,58.47010803,20130329
FT329B,0.5,,CAL,ok,3.971277714,79.89271545,20130329
FT329B,0.8,,CAL,ok,3.968937635,120.88237,20130329
,no data,,,ok,NA,NA,
FT329C,CHK N2O,,CHK,ok,3.964125872,112.4910507,20130329
FT329C,CHK CH4,,CHK,ok,0,0,20130329
FT329C,0.33,,CAL,ok,3.95931673,49.84948349,20130329
FT329C,0.5,,CAL,ok,3.961132765,71.58917236,20130329
FT329C,0.8,,CAL,ok,3.955530882,101.7675476,20130329
FT329C,CHT-1-1,0.083,,ok,3.931046724,49.80604172,20130329
FT329C,CHT-1-2,20,,ok,3.962275028,50.85053635,20130329
FT329C,CHT-1-3,40,,ok,3.949534655,53.66729355,20130329
FT329C,CHT-1-4,60,,ok,3.917159557,51.98723984,20130329
FT329C,CHT-2-1,0.083,,ok,3.945843935,51.16890717,20130329
FT329C,CHT-2-2,20,,ok,3.953123093,53.26094055,20130329
FT329C,CHT-2-3,40,,ok,3.951769352,52.60631561,20130329
FT329C,CHT-2-4,60,,ok,3.949804068,54.405056,20130329

FT329C,CHC-1-1,0.083,,ok,3.960775614,50.75168228,20130329
FT329C,CHC-1-2,20,,ok,3.956127882,51.50386047,20130329
FT329C,CHC-1-3,40,,ok,3.951065302,51.54031372,20130329
FT329C,CHC-1-4,60,,ok,3.959538221,52.9129982,20130329
FT329C,CHC-2-1,0.083,,ok,3.951012373,53.37218857,20130329
FT329C,CHC-2-2,20,,ok,3.953402519,53.0381279,20130329
FT329C,CHC-2-3,40,,ok,3.957727194,51.96546555,20130329
FT329C,CHC-2-4,60,,ok,3.962145567,53.31792068,20130329
FT329C,CLT-1-1,0.083,,ok,3.95794487,52.44478226,20130329
FT329C,CLT-1-2,20,,ok,3.95428133,54.70482635,20130329
FT329C,CLT-1-3,40,,ok,3.957008123,56.36958694,20130329
FT329C,CLT-1-4,60,,ok,3.952260017,54.07503891,20130329
FT329C,CLT-2-1,0.083,,ok,3.945287943,52.99184799,20130329
FT329C,CLT-2-2,20,,ok,3.954114199,54.98041916,20130329
FT329C,CLT-2-3,40,,ok,3.966200352,53.08527374,20130329
FT329C,CLT-2-4,60,,ok,3.953804016,53.97198105,20130329
FT329C,CLC-1-1,0.083,,ok,3.96642828,55.05021286,20130329
FT329C,CLC-1-2,20,,ok,3.958527803,54.06521225,20130329
FT329C,CLC-1-3,40,,ok,3.951777935,52.75689316,20130329
FT329C,CLC-1-4,60,,ok,3.953188658,52.85522079,20130329
FT329C,CLC-2-1,0.083,,ok,3.95270443,55.8328743,20130329
FT329C,CLC-2-2,20,,ok,3.958357573,53.43303299,20130329
FT329C,CLC-2-3,40,,ok,3.952186823,54.33010864,20130329
FT329C,CLC-2-4,60,,ok,3.958324432,54.63843918,20130329
FT329C,0.33,,CAL,ok,3.964523792,58.87150192,20130329
FT329C,0.5,,CAL,ok,3.956507206,79.88900757,20130329
FT329C,0.8,,CAL,ok,3.951622486,118.9293823,20130329
,no data,,,ok,NA,NA,
FT330A,CHK N2O,,CHK,ok,3.94951272,163.8016357,20130330
FT330A,CHK CH4,,CHK,ok,0,0,20130330
FT330A,0.33,,CAL,ok,3.95480442,55.89030838,20130330
FT330A,0.5,,CAL,ok,3.959874153,77.85729218,20130330
FT330A,0.8,,CAL,ok,3.955836535,117.9439621,20130330
FT330A,AHT-1-1,0.083,,ok,3.961018801,53.28760529,20130330
FT330A,AHT-1-2,20,,ok,3.960229158,53.00936508,20130330
FT330A,AHT-1-3,40,,ok,3.959056854,54.84905243,20130330
FT330A,AHT-1-4,60,,ok,3.95176816,53.48165512,20130330
FT330A,AHT-2-1,0.083,,ok,3.955575466,53.04375458,20130330
FT330A,AHT-2-2,20,,ok,3.955290079,53.55208588,20130330
FT330A,AHT-2-3,40,,ok,3.982762575,53.8118782,20130330
FT330A,AHT-2-4,60,,ok,3.952344656,51.47919083,20130330
FT330A,AHC-1-1,0.083,,ok,3.962601423,55.62321472,20130330
FT330A,AHC-1-2,20,,ok,3.959191799,52.52052307,20130330
FT330A,AHC-1-3,40,,ok,3.959456921,54.63397217,20130330
FT330A,AHC-1-4,60,,ok,3.950895309,53.92410278,20130330
FT330A,AHC-2-1,0.083,,ok,3.950856686,52.57706451,20130330
FT330A,AHC-2-2,20,,ok,3.95876503,52.70207214,20130330
FT330A,AHC-2-3,40,,ok,3.954638481,53.02415085,20130330
FT330A,AHC-2-4,60,,ok,3.95557785,54.00798798,20130330
FT330A,ALT-1-1,0.083,,ok,3.959481478,52.19510269,20130330
FT330A,ALT-1-2,20,,ok,3.964558363,53.10937881,20130330
FT330A,ALT-1-3,40,,ok,3.958571196,53.14896011,20130330
FT330A,ALT-1-4,60,,ok,3.962357521,55.06708527,20130330
FT330A,ALT-2-1,0.083,,ok,3.961836815,52.04445648,20130330
FT330A,ALT-2-2,20,,ok,3.959648609,52.54123306,20130330
FT330A,ALT-2-3,40,,ok,3.960097075,54.42418671,20130330
FT330A,ALT-2-4,60,,ok,3.959275723,50.9843483,20130330
FT330A,ALC-1-1,0.083,,ok,3.961970568,53.43504715,20130330
FT330A,ALC-1-2,20,,ok,3.94910574,53.1942215,20130330
FT330A,ALC-1-3,40,,ok,3.962366343,53.14625168,20130330
FT330A,ALC-1-4,60,,ok,3.958804131,54.12066269,20130330
FT330A,ALC-2-1,0.083,,ok,3.953911781,53.79838943,20130330

FT330A,ALC-2-2,20,,ok,3.945432901,51.3117981,20130330
FT330A,ALC-2-3,40,,ok,3.960031271,52.50849915,20130330
FT330A,ALC-2-4,60,,REJY,0,0,20130330
FT330A,0.33,,CAL,REJY,0,0,20130330
FT330A,0.5,,CAL,REJY,0,0,20130330
FT330A,0.8,,CAL,REJY,0,0,20130330
,no data,,,ok,NA,NA,
FT330B,CHK N2O,,CHK,ok,3.955783367,143.562439,20130330
FT330B,CHK CH4,,CHK,ok,0,0,20130330
FT330B,0.33,,CAL,ok,3.953591824,50.82583618,20130330
FT330B,0.5,,CAL,ok,3.953330278,75.25727844,20130330
FT330B,0.8,,CAL,ok,3.952131748,105.7847977,20130330
FT330B,BHT-1-1,0.083,,ok,3.946388721,50.92922974,20130330
FT330B,BHT-1-2,20,,ok,3.949717045,48.7687645,20130330
FT330B,BHT-1-3,40,,ok,3.94951582,52.74360657,20130330
FT330B,BHT-1-4,60,,ok,3.941943169,50.72579575,20130330
FT330B,BHT-2-1,0.083,,ok,3.94816494,50.46603394,20130330
FT330B,BHT-2-2,20,,ok,3.955583811,51.21333694,20130330
FT330B,BHT-2-3,40,,ok,3.949617863,50.97370148,20130330
FT330B,BHT-2-4,60,,ok,3.950174332,50.3711586,20130330
FT330B,BHC-1-1,0.083,,ok,3.949718237,51.33097076,20130330
FT330B,BHC-1-2,20,,ok,3.950592279,50.77550507,20130330
FT330B,BHC-1-3,40,,ok,3.938317299,51.14508057,20130330
FT330B,BHC-1-4,60,,ok,3.94263792,52.42229462,20130330
FT330B,BHC-2-1,0.083,,ok,3.945639372,52.32697678,20130330
FT330B,BHC-2-2,20,,ok,3.94562149,51.28515244,20130330
FT330B,BHC-2-3,40,,REJY,0,0,20130330
FT330B,BHC-2-4,60,,ok,3.947845459,49.94875336,20130330
FT330B,BLT-1-1,0.083,,ok,3.940237284,52.5990448,20130330
FT330B,BLT-1-2,20,,ok,3.954949856,53.64388657,20130330
FT330B,BLT-1-3,40,,ok,3.941705465,54.17979431,20130330
FT330B,BLT-1-4,60,,ok,3.955971718,53.82035828,20130330
FT330B,BLT-2-1,0.083,,ok,3.957336903,53.05155182,20130330
FT330B,BLT-2-2,20,,ok,3.951357841,51.43625259,20130330
FT330B,BLT-2-3,40,,ok,3.952792883,52.4393158,20130330
FT330B,BLT-2-4,60,,ok,3.948350191,52.99698257,20130330
FT330B,BLC-1-1,0.083,,ok,3.947555065,50.25083542,20130330
FT330B,BLC-1-2,20,,ok,3.949701786,49.72687912,20130330
FT330B,BLC-1-3,40,,ok,3.950727701,55.06062698,20130330
FT330B,BLC-1-4,60,,ok,3.946117878,52.51927567,20130330
FT330B,BLC-2-1,0.083,,ok,3.947126865,52.0220871,20130330
FT330B,BLC-2-2,20,,ok,3.951958656,53.30996323,20130330
FT330B,BLC-2-3,40,,ok,3.954220772,54.70394516,20130330
FT330B,BLC-2-4,60,,ok,3.95277524,53.10041809,20130330
FT330B,0.33,,CAL,ok,3.946117878,56.77944946,20130330
FT330B,0.5,,CAL,ok,3.951958895,78.80298615,20130330
FT330B,0.8,,CAL,ok,3.95614028,118.5383606,20130330
,no data,,,ok,NA,NA,
FT330C,CHK N2O,,CHK,ok,3.947532654,164.5523376,20130330
FT330C,CHK CH4,,CHK,ok,0,0,20130330
FT330C,0.33,,CAL,ok,3.955056667,56.25791931,20130330
FT330C,0.5,,CAL,ok,3.95690155,78.04312897,20130330
FT330C,0.8,,CAL,ok,3.956319809,114.4842758,20130330
FT330C,CHT-1-1,0.083,,ok,3.94587183,55.76303482,20130330
FT330C,CHT-1-2,20,,ok,3.945870876,55.98721695,20130330
FT330C,CHT-1-3,40,,ok,3.953518629,54.94816208,20130330
FT330C,CHT-1-4,60,,ok,3.939698458,54.52999496,20130330
FT330C,CHT-2-1,0.083,,ok,3.956252098,52.85866547,20130330
FT330C,CHT-2-2,20,,ok,3.948047876,51.81240845,20130330
FT330C,CHT-2-3,40,,ok,3.950750351,52.30271149,20130330
FT330C,CHT-2-4,60,,ok,3.949116468,54.6138649,20130330
FT330C,CHC-1-1,0.083,,ok,3.953389168,50.74616623,20130330

FT330C,CHC-1-2,20,,ok,3.949789524,53.77800751,20130330
FT330C,CHC-1-3,40,,ok,3.957262993,52.7340126,20130330
FT330C,CHC-1-4,60,,ok,3.946908951,51.79729462,20130330
FT330C,CHC-2-1,0.083,,ok,3.957939386,53.73345184,20130330
FT330C,CHC-2-2,20,,ok,3.963135004,53.49198532,20130330
FT330C,CHC-2-3,40,,ok,3.955585241,54.40158844,20130330
FT330C,CHC-2-4,60,,ok,3.953889847,54.56144333,20130330
FT330C,CLT-1-1,0.083,,ok,3.954032421,51.62830734,20130330
FT330C,CLT-1-2,20,,ok,3.956129074,52.43729401,20130330
FT330C,CLT-1-3,40,,ok,3.953493357,51.60775375,20130330
FT330C,CLT-1-4,60,,ok,3.949543953,52.76256561,20130330
FT330C,CLT-2-1,0.083,,ok,3.958301067,54.20313263,20130330
FT330C,CLT-2-2,20,,ok,3.951360703,52.56389236,20130330
FT330C,CLT-2-3,40,,ok,3.952327251,54.41083527,20130330
FT330C,CLT-2-4,60,,ok,3.946606874,54.62825012,20130330
FT330C,CLC-1-1,0.083,,ok,3.955614805,52.31079865,20130330
FT330C,CLC-1-2,20,,ok,3.949491978,52.86958694,20130330
FT330C,CLC-1-3,40,,ok,3.947796583,52.02412415,20130330
FT330C,CLC-1-4,60,,ok,3.953533411,53.21636581,20130330
FT330C,CLC-2-1,0.083,,ok,3.949775219,53.72946167,20130330
FT330C,CLC-2-2,20,,ok,3.9567523,52.37588501,20130330
FT330C,CLC-2-3,40,,ok,3.944312334,53.16851044,20130330
FT330C,CLC-2-4,60,,ok,3.954539776,51.22937775,20130330
FT330C,0.33,,CAL,ok,3.957262039,56.74935913,20130330
FT330C,0.5,,CAL,ok,3.943431139,78.29940033,20130330
FT330C,0.8,,CAL,ok,3.958698034,113.6896896,20130330
FT331A,CHK N2O,,CHK,ok,3.980162859,148.7410431,20130331
FT331A,CHK CH4,,CHK,ok,0,0,20130331
FT331A,0.33,,CAL,ok,3.984334707,49.05656433,20130331
FT331A,0.5,,CAL,ok,3.971607447,69.85980988,20130331
FT331A,0.8,,CAL,ok,3.976599693,107.8632736,20130331
FT331A,AHT-1-1,0.083,,ok,4.009331226,47.18044281,20130331
FT331A,AHT-1-2,20,,ok,3.976241827,49.13528442,20130331
FT331A,AHT-1-3,40,,ok,3.969259262,48.25678253,20130331
FT331A,AHT-1-4,60,,ok,3.978641033,49.31707764,20130331
FT331A,AHT-2-1,0.083,,ok,3.979548454,48.59696579,20130331
FT331A,AHT-2-2,20,,ok,3.972316742,48.13217545,20130331
FT331A,AHT-2-3,40,,ok,3.980838776,50.57683182,20130331
FT331A,AHT-2-4,60,,ok,3.974894762,49.04577637,20130331
FT331A,AHC-1-1,0.083,,ok,3.98286891,49.9714241,20130331
FT331A,AHC-1-2,20,,ok,3.970085382,48.78776932,20130331
FT331A,AHC-1-3,40,,ok,3.978417873,50.70589066,20130331
FT331A,AHC-1-4,60,,ok,3.978725433,53.82370377,20130331
FT331A,AHC-2-1,0.083,,ok,3.973220587,49.01260757,20130331
FT331A,AHC-2-2,20,,ok,3.969607115,52.10733795,20130331
FT331A,AHC-2-3,40,,ok,3.971386194,51.36566925,20130331
FT331A,AHC-2-4,60,,ok,3.981741667,50.17939758,20130331
FT331A,ALT-1-1,0.083,,ok,3.979070425,50.26686096,20130331
FT331A,ALT-1-2,20,,ok,3.978008032,51.00064468,20130331
FT331A,ALT-1-3,40,,ok,3.974434614,51.07808304,20130331
FT331A,ALT-1-4,60,,ok,3.967947721,51.46907425,20130331
FT331A,ALT-2-1,0.083,,ok,3.973594904,50.62562943,20130331
FT331A,ALT-2-2,20,,ok,3.976002216,51.07971573,20130331
FT331A,ALT-2-3,40,,ok,3.98160553,51.34062576,20130331
FT331A,ALT-2-4,60,,ok,3.97163868,53.31594467,20130331
FT331A,ALC-1-1,0.083,,ok,3.970770597,51.41810989,20130331
FT331A,ALC-1-2,20,,ok,3.984980106,52.25597763,20130331
FT331A,ALC-1-3,40,,ok,3.980371952,51.45358658,20130331
FT331A,ALC-1-4,60,,ok,3.980908394,53.12641525,20130331
FT331A,ALC-2-1,0.083,,ok,3.976801395,52.33714676,20130331
FT331A,ALC-2-2,20,,ok,3.986766338,51.33721542,20130331
FT331A,ALC-2-3,40,,ok,3.967376471,51.94973755,20130331

FT331A,ALC-2-4,60,,ok,3.981560707,50.50466919,20130331
FT331A,0.33,,CAL,ok,3.980900526,56.73809052,20130331
FT331A,0.5,,CAL,ok,3.977769852,75.05252075,20130331
FT331A,0.8,,CAL,ok,3.977491379,108.953743,20130331
,no data,,,ok,NA,NA,
FT331B,CHK N2O,,CHK,ok,3.987579107,155.367569,20130331
FT331B,CHK CH4,,CHK,ok,0,0,20130331
FT331B,0.33,,CAL,ok,3.976272583,53.6630249,20130331
FT331B,0.5,,CAL,ok,3.969844103,74.20396423,20130331
FT331B,0.8,,CAL,ok,3.971218348,113.8520813,20130331
FT331B,BHT-1-1,0.083,,ok,3.972978115,51.86836624,20130331
FT331B,BHT-1-2,20,,ok,3.980583429,50.36248016,20130331
FT331B,BHT-1-3,40,,ok,3.98029685,50.60573196,20130331
FT331B,BHT-1-4,60,,ok,3.971562624,50.21936035,20130331
FT331B,BHT-2-1,0.083,,ok,3.970152378,52.56291962,20130331
FT331B,BHT-2-2,20,,ok,3.988632202,52.32774734,20130331
FT331B,BHT-2-3,40,,ok,3.981205225,49.75918579,20130331
FT331B,BHT-2-4,60,,ok,3.974385738,54.80566025,20130331
FT331B,BHC-1-1,0.083,,ok,3.971528769,53.3651123,20130331
FT331B,BHC-1-2,20,,ok,3.98081398,50.12229538,20130331
FT331B,BHC-1-3,40,,ok,3.972990751,51.07932663,20130331
FT331B,BHC-1-4,60,,ok,3.976398468,51.67854309,20130331
FT331B,BHC-2-1,0.083,,ok,3.97615099,51.67211151,20130331
FT331B,BHC-2-2,20,,ok,3.977093935,50.34541321,20130331
FT331B,BHC-2-3,40,,ok,3.984721661,50.4834404,20130331
FT331B,BHC-2-4,60,,ok,3.978350163,51.37583542,20130331
FT331B,BLT-1-1,0.083,,ok,3.981968403,52.39279556,20130331
FT331B,BLT-1-2,20,,ok,3.977970123,48.90041733,20130331
FT331B,BLT-1-3,40,,ok,3.984456062,50.42683792,20130331
FT331B,BLT-1-4,60,,ok,3.978712082,52.19067001,20130331
FT331B,BLT-2-1,0.083,,ok,3.976558208,52.06720734,20130331
FT331B,BLT-2-2,20,,ok,3.97273922,53.93419647,20130331
FT331B,BLT-2-3,40,,ok,3.976280451,53.24411011,20130331
FT331B,BLT-2-4,60,,ok,3.978055,55.29719162,20130331
FT331B,BLC-1-1,0.083,,ok,3.969986916,52.05130386,20130331
FT331B,BLC-1-2,20,,ok,3.976314068,51.35453796,20130331
FT331B,BLC-1-3,40,,ok,3.970222235,51.6512413,20130331
FT331B,BLC-1-4,60,,ok,3.981254339,53.73854446,20130331
FT331B,BLC-2-1,0.083,,ok,3.976274014,52.17354584,20130331
FT331B,BLC-2-2,20,,ok,3.974732876,51.36083603,20130331
FT331B,BLC-2-3,40,,ok,3.980608225,52.00394058,20130331
FT331B,BLC-2-4,60,,ok,3.974780083,52.43479538,20130331
FT331B,0.33,,CAL,ok,3.983928919,55.87113953,20130331
FT331B,0.5,,CAL,ok,3.976108074,77.86264038,20130331
FT331B,0.8,,CAL,ok,3.974959612,113.7062531,20130331
,no data,,,ok,NA,NA,
FT331C,CHK N2O,,CHK,ok,3.983709812,138.4674377,20130331
FT331C,CHK CH4,,CHK,ok,0,0,20130331
FT331C,0.33,,CAL,ok,3.977573872,50.74892426,20130331
FT331C,0.5,,CAL,ok,3.981036663,66.55089569,20130331
FT331C,0.8,,CAL,ok,3.975455046,99.00679016,20130331
FT331C,CHT-1-1,0.083,,ok,3.974631071,48.38489914,20130331
FT331C,CHT-1-2,20,,ok,3.970387459,49.19920349,20130331
FT331C,CHT-1-3,40,,ok,3.975700855,48.61826324,20130331
FT331C,CHT-1-4,60,,ok,3.975800037,49.30927277,20130331
FT331C,CHT-2-1,0.083,,ok,3.970970154,51.13508987,20130331
FT331C,CHT-2-2,20,,ok,3.971367359,50.21720886,20130331
FT331C,CHT-2-3,40,,ok,3.979682922,48.35000229,20130331
FT331C,CHT-2-4,60,,ok,3.978544712,49.78085327,20130331
FT331C,CHC-1-1,0.083,,ok,3.985506535,51.43399429,20130331
FT331C,CHC-1-2,20,,ok,3.975900173,49.14500427,20130331
FT331C,CHC-1-3,40,,ok,3.971038342,50.43902206,20130331

FT331C,CHC-1-4,60,,ok,3.978119373,50.06191635,20130331
FT331C,CHC-2-1,0.083,,ok,3.977919817,49.05947113,20130331
FT331C,CHC-2-2,20,,ok,3.973497629,50.11930847,20130331
FT331C,CHC-2-3,40,,ok,3.97316885,52.57535553,20130331
FT331C,CHC-2-4,60,,ok,3.968886375,51.0271492,20130331
FT331C,CLT-1-1,0.083,,ok,3.977802753,51.17322159,20130331
FT331C,CLT-1-2,20,,ok,3.976974964,47.32217789,20130331
FT331C,CLT-1-3,40,,ok,3.970342875,51.1948967,20130331
FT331C,CLT-1-4,60,,ok,3.973003387,50.7417984,20130331
FT331C,CLT-2-1,0.083,,ok,3.973891258,51.74574661,20130331
FT331C,CLT-2-2,20,,ok,3.971698046,51.72797012,20130331
FT331C,CLT-2-3,40,,ok,3.978576183,52.45940781,20130331
FT331C,CLT-2-4,60,,ok,3.976019621,52.05723572,20130331
FT331C,CLC-1-1,0.083,,ok,3.976264954,50.6805191,20130331
FT331C,CLC-1-2,20,,ok,3.969818354,51.75237656,20130331
FT331C,CLC-1-3,40,,ok,3.967408419,51.38104248,20130331
FT331C,CLC-1-4,60,,ok,3.972688437,51.96953583,20130331
FT331C,CLC-2-1,0.083,,ok,3.97917223,49.31232071,20130331
FT331C,CLC-2-2,20,,ok,3.965758324,50.32611847,20130331
FT331C,CLC-2-3,40,,ok,3.976115227,49.58380127,20130331
FT331C,CLC-2-4,60,,ok,3.969658613,49.80070877,20130331
FT331C,0.33,,CAL,ok,3.987477064,53.68896103,20130331
FT331C,0.5,,CAL,ok,3.969539881,75.83721161,20130331
FT331C,0.8,,CAL,ok,3.978508711,112.5766983,20130331
,no data,,,ok,NA,NA,
FT401A,CHK N2O,,CHK,ok,3.975093842,164.0400543,20130401
FT401A,CHK CH4,,CHK,ok,0,0,20130401
FT401A,0.33,,CAL,ok,3.982041359,54.69677353,20130401
FT401A,0.5,,CAL,ok,3.984433413,75.37142944,20130401
FT401A,0.8,,CAL,ok,3.983232975,115.5305023,20130401
FT401A,AHT-1-1,0.083,,ok,3.980269432,52.69449615,20130401
FT401A,AHT-1-2,20,,ok,3.986293793,52.62134552,20130401
FT401A,AHT-1-3,40,,ok,3.984903097,50.97854614,20130401
FT401A,AHT-1-4,60,,ok,3.981920004,50.29417801,20130401
FT401A,AHT-2-1,0.083,,ok,3.979984045,51.69649124,20130401
FT401A,AHT-2-2,20,,ok,3.981152773,50.91562653,20130401
FT401A,AHT-2-3,40,,ok,3.984497786,50.41729355,20130401
FT401A,AHT-2-4,60,,ok,3.985141993,51.32720184,20130401
FT401A,AHC-1-1,0.083,,ok,3.99262619,50.94353485,20130401
FT401A,AHC-1-2,20,,ok,3.983546257,51.64661026,20130401
FT401A,AHC-1-3,40,,ok,3.98069787,50.71847534,20130401
FT401A,AHC-1-4,60,,ok,3.986532927,52.27729416,20130401
FT401A,AHC-2-1,0.083,,ok,3.979564905,49.27272034,20130401
FT401A,AHC-2-2,20,,ok,3.988335609,49.41187668,20130401
FT401A,AHC-2-3,40,,ok,3.985392809,49.33689117,20130401
FT401A,AHC-2-4,60,,ok,3.98220396,51.67967606,20130401
FT401A,ALT-1-1,0.083,,ok,3.989998341,50.57443237,20130401
FT401A,ALT-1-2,20,,REJY,0,0,20130401
FT401A,ALT-1-3,40,,REJY,0,0,20130401
FT401A,ALT-1-4,60,,REJY,0,0,20130401
FT401A,ALT-2-1,0.083,,REJY,0,0,20130401
FT401A,ALT-2-2,20,,REJY,0,0,20130401
FT401A,ALT-2-3,40,,REJY,0,0,20130401
FT401A,ALT-2-4,60,,REJY,0,0,20130401
FT401A,ALC-1-1,0.083,,REJY,0,0,20130401
FT401A,ALC-1-2,20,,REJY,0,0,20130401
FT401A,ALC-1-3,40,,REJY,0,0,20130401
FT401A,ALC-1-4,60,,REJY,0,0,20130401
FT401A,ALC-2-1,0.083,,REJY,0,0,20130401
FT401A,ALC-2-2,20,,REJY,0,0,20130401
FT401A,ALC-2-3,40,,REJY,0,0,20130401
FT401A,ALC-2-4,60,,REJY,0,0,20130401

FT401A,0.33,,CAL,REJY,0,0,20130401
FT401A,0.5,,CAL,REJY,0,0,20130401
FT401A,0.8,,CAL,REJY,0,0,20130401
,no data,,,ok,NA,NA,
FT401AA,0.33,,CAL,ok,4.00141716,40.93713379,20130401
FT401AA,0.5,,CAL,ok,3.990115166,56.20114517,20130401
FT401AA,0.8,,CAL,ok,3.985699415,85.5154953,20130401
FT401AA,ALT-1-2,20,,ok,3.981362343,36.05479431,20130401
FT401AA,ALT-1-3,40,,ok,3.979123116,38.00824356,20130401
FT401AA,ALT-1-4,60,,ok,4.001825809,37.65718079,20130401
FT401AA,ALT-2-1,0.083,,ok,3.986631393,36.27161789,20130401
FT401AA,ALT-2-2,20,,ok,3.999645233,37.7254715,20130401
FT401AA,ALT-2-3,40,,ok,3.995215178,38.41355133,20130401
FT401AA,ALT-2-4,60,,ok,3.997878313,36.51133728,20130401
FT401AA,ALC-1-1,0.083,,ok,3.987520218,36.9328804,20130401
FT401AA,ALC-1-2,20,,ok,4.004946709,34.52402496,20130401
FT401AA,ALC-1-3,40,,ok,3.991268635,37.17965698,20130401
FT401AA,ALC-1-4,60,,ok,3.993925571,38.8197937,20130401
FT401AA,ALC-2-1,0.083,,ok,4.001480103,37.10108566,20130401
FT401AA,ALC-2-2,20,,ok,3.961841583,35.74032974,20130401
FT401AA,ALC-2-3,40,,ok,3.984584808,34.61375046,20130401
FT401AA,ALC-2-4,60,,ok,3.98575592,36.90671158,20130401
FT401AA,0.33,,CAL,ok,3.9842875,39.19396973,20130401
FT401AA,0.5,,CAL,ok,3.983704567,55.04843903,20130401
FT401AA,0.8,,CAL,ok,3.990698338,81.2339859,20130401
,no data,,,ok,NA,NA,
FT401B,CHK N2O,,CHK,ok,3.95470953,139.5657654,20130401
FT401B,CHK CH4,,CHK,ok,0,0,20130401
FT401B,0.33,,CAL,ok,3.955784321,49.69947052,20130401
FT401B,0.5,,CAL,ok,3.958160162,72.91552734,20130401
FT401B,0.8,,CAL,ok,3.95442605,112.7809448,20130401
FT401B,BHT-1-1,0.083,,ok,3.952263594,49.50534058,20130401
FT401B,BHT-1-2,20,,ok,3.949011087,49.17460251,20130401
FT401B,BHT-1-3,40,,ok,3.960062027,49.08272171,20130401
FT401B,BHT-1-4,60,,ok,3.949215174,51.36229324,20130401
FT401B,BHT-2-1,0.083,,ok,3.957354069,51.61083603,20130401
FT401B,BHT-2-2,20,,ok,3.960662842,49.70708466,20130401
FT401B,BHT-2-3,40,,ok,3.947361231,52.64271164,20130401
FT401B,BHT-2-4,60,,ok,3.961876869,52.45228195,20130401
FT401B,BHC-1-1,0.083,,ok,3.95277667,52.05112839,20130401
FT401B,BHC-1-2,20,,ok,3.963754177,52.53570557,20130401
FT401B,BHC-1-3,40,,ok,3.959418774,50.00939178,20130401
FT401B,BHC-1-4,60,,ok,3.959433079,53.63078308,20130401
FT401B,BHC-2-1,0.083,,ok,3.965246677,47.87573242,20130401
FT401B,BHC-2-2,20,,ok,3.960253,50.16469193,20130401
FT401B,BHC-2-3,40,,ok,3.96113801,52.30115891,20130401
FT401B,BHC-2-4,60,,ok,3.95435977,52.09625244,20130401
FT401B,BLT-1-1,0.083,,ok,3.953438282,51.60979462,20130401
FT401B,BLT-1-2,20,,ok,3.956287861,53.95976639,20130401
FT401B,BLT-1-3,40,,ok,3.986136198,52.73218155,20130401
FT401B,BLT-1-4,60,,ok,3.953451395,55.80853653,20130401
FT401B,BLT-2-1,0.083,,ok,3.959518671,51.0616684,20130401
FT401B,BLT-2-2,20,,ok,3.960445881,55.34400558,20130401
FT401B,BLT-2-3,40,,ok,3.952341557,54.15278625,20130401
FT401B,BLT-2-4,60,,ok,3.967726231,53.95668793,20130401
FT401B,BLC-1-1,0.083,,ok,3.960742712,53.05170822,20130401
FT401B,BLC-1-2,20,,ok,3.956223249,52.29229736,20130401
FT401B,BLC-1-3,40,,ok,3.974263668,52.51493073,20130401
FT401B,BLC-1-4,60,,ok,3.962412596,51.15659332,20130401
FT401B,BLC-2-1,0.083,,ok,3.968945265,54.56403351,20130401
FT401B,BLC-2-2,20,,ok,3.966191053,54.39015579,20130401
FT401B,BLC-2-3,40,,ok,3.963668346,54.47708511,20130401

FT401B,BLC-2-4,60,,ok,3.982350111,51.21844864,20130401
FT401B,0.33,,CAL,ok,3.970010757,57.58914948,20130401
FT401B,0.5,,CAL,ok,3.968686342,76.45680237,20130401
FT401B,0.8,,CAL,ok,3.968115568,114.5892792,20130401
,no data,,,ok,NA,NA,
FT401C,CHK N2O,,CHK,ok,3.953107595,157.0054321,20130401
FT401C,CHK CH4,,CHK,ok,0,0,20130401
FT401C,0.33,,CAL,ok,3.971043587,52.60458755,20130401
FT401C,0.5,,CAL,ok,3.966215611,79.6395874,20130401
FT401C,0.8,,CAL,ok,3.962029219,114.9691696,20130401
FT401C,CHT-1-1,0.083,,ok,3.961692572,54.52562714,20130401
FT401C,CHT-1-2,20,,ok,3.967154503,51.94323349,20130401
FT401C,CHT-1-3,40,,ok,3.962320089,49.0916748,20130401
FT401C,CHT-1-4,60,,ok,3.955991983,51.85718918,20130401
FT401C,CHT-2-1,0.083,,ok,3.967096806,51.2621727,20130401
FT401C,CHT-2-2,20,,ok,3.961951971,53.65414429,20130401
FT401C,CHT-2-3,40,,ok,3.964052916,53.47518158,20130401
FT401C,CHT-2-4,60,,ok,3.957531691,52.84962463,20130401
FT401C,CHC-1-1,0.083,,ok,3.954509974,51.20746994,20130401
FT401C,CHC-1-2,20,,ok,3.962557554,51.01937866,20130401
FT401C,CHC-1-3,40,,ok,3.954908848,51.84104919,20130401
FT401C,CHC-1-4,60,,ok,3.954967976,50.46562576,20130401
FT401C,CHC-2-1,0.083,,ok,3.959251642,51.87760544,20130401
FT401C,CHC-2-2,20,,ok,3.953906059,52.27243423,20130401
FT401C,CHC-2-3,40,,ok,3.956838608,53.04368973,20130401
FT401C,CHC-2-4,60,,ok,3.957807302,51.39258957,20130401
FT401C,CLT-1-1,0.083,,ok,3.948003531,55.92273712,20130401
FT401C,CLT-1-2,20,,ok,3.960764408,49.69854355,20130401
FT401C,CLT-1-3,40,,ok,3.946813345,52.15270996,20130401
FT401C,CLT-1-4,60,,ok,3.95582509,52.46283722,20130401
FT401C,CLT-2-1,0.083,,ok,3.961446285,51.13067245,20130401
FT401C,CLT-2-2,20,,ok,3.960659027,52.56611633,20130401
FT401C,CLT-2-3,40,,ok,3.946681976,52.19812775,20130401
FT401C,CLT-2-4,60,,ok,3.945245981,51.32041931,20130401
FT401C,CLC-1-1,0.083,,ok,3.95185256,51.79415894,20130401
FT401C,CLC-1-2,20,,ok,3.939702749,48.79281235,20130401
FT401C,CLC-1-3,40,,ok,3.952333689,50.85904694,20130401
FT401C,CLC-1-4,60,,ok,3.951496363,51.56864929,20130401
FT401C,CLC-2-1,0.083,,ok,3.953602791,48.25187683,20130401
FT401C,CLC-2-2,20,,ok,3.953916788,50.75497055,20130401
FT401C,CLC-2-3,40,,ok,3.94734931,51.08538437,20130401
FT401C,CLC-2-4,60,,ok,3.953025103,52.10212326,20130401
FT401C,0.33,,CAL,ok,3.944738626,55.52033234,20130401
FT401C,0.5,,CAL,ok,3.945028782,76.89709473,20130401
FT401C,0.8,,CAL,ok,3.955318689,120.0212479,20130401
,no data,,,ok,NA,NA,
FT402A,CHK N2O,,CHK,ok,3.975077629,164.1139526,20130402
FT402A,CHK CH4,,CHK,ok,0,0,20130402
FT402A,0.33,,CAL,ok,3.971208334,54.51844025,20130402
FT402A,0.5,,CAL,ok,3.971482277,77.7830658,20130402
FT402A,0.8,,CAL,ok,3.971284151,109.0757751,20130402
FT402A,AHT-1-1,0.083,,ok,3.978793144,49.41347122,20130402
FT402A,AHT-1-2,20,,ok,3.97325325,50.12505341,20130402
FT402A,AHT-1-3,40,,ok,3.967295647,50.2352066,20130402
FT402A,AHT-1-4,60,,ok,3.965894222,52.69556427,20130402
FT402A,AHT-2-1,0.083,,ok,3.983322859,51.81291962,20130402
FT402A,AHT-2-2,20,,ok,3.989733219,51.67292023,20130402
FT402A,AHT-2-3,40,,ok,3.974461317,50.14549637,20130402
FT402A,AHT-2-4,60,,ok,3.969740391,52.01763153,20130402
FT402A,AHC-1-1,0.083,,ok,3.979597569,50.18159866,20130402
FT402A,AHC-1-2,20,,ok,3.975291252,52.219944,20130402
FT402A,AHC-1-3,40,,ok,3.970012665,51.26625443,20130402

FT402A,AHC-1-4,60,,ok,3.972592115,51.6232872,20130402
FT402A,AHC-2-1,0.083,,ok,3.973327637,53.00229263,20130402
FT402A,AHC-2-2,20,,ok,3.969978571,50.48271179,20130402
FT402A,AHC-2-3,40,,ok,3.972420216,49.54156113,20130402
FT402A,AHC-2-4,60,,ok,3.975872993,54.57041931,20130402
FT402A,ALT-1-1,0.083,,ok,3.978495598,52.73218155,20130402
FT402A,ALT-1-2,20,,ok,3.970422745,51.960289,20130402
FT402A,ALT-1-3,40,,ok,3.967300415,52.72319031,20130402
FT402A,ALT-1-4,60,,ok,3.976802111,51.12082672,20130402
FT402A,ALT-2-1,0.083,,ok,3.974441051,52.88769531,20130402
FT402A,ALT-2-2,20,,ok,3.976487398,50.44250107,20130402
FT402A,ALT-2-3,40,,ok,3.998450994,50.4466095,20130402
FT402A,ALT-2-4,60,,ok,3.995638609,52.40759659,20130402
FT402A,ALC-1-1,0.083,,ok,3.977384329,51.15947723,20130402
FT402A,ALC-1-2,20,,ok,3.981843948,52.14820862,20130402
FT402A,ALC-1-3,40,,ok,3.98001194,52.23583603,20130402
FT402A,ALC-1-4,60,,ok,3.995803118,51.11427307,20130402
FT402A,ALC-2-1,0.083,,ok,3.985073805,50.68674088,20130402
FT402A,ALC-2-2,20,,ok,4.003606796,50.62485886,20130402
FT402A,ALC-2-3,40,,ok,3.997859001,53.3021965,20130402
FT402A,ALC-2-4,60,,ok,3.991510153,51.75229263,20130402
FT402A,0.33,,CAL,ok,4.000035763,54.23036575,20130402
FT402A,0.5,,CAL,ok,3.995515823,73.80667114,20130402
FT402A,0.8,,CAL,ok,3.998284578,113.9065857,20130402
,no data,,,ok,NA,NA,
FT402B,CHK N2O,,CHK,ok,3.971372366,159.2433624,20130402
FT402B,CHK CH4,,CHK,ok,0,0,20130402
FT402B,0.33,,CAL,ok,3.974636793,53.59075546,20130402
FT402B,0.5,,CAL,ok,3.978417635,71.77375031,20130402
FT402B,0.8,,CAL,ok,3.980144739,111.0666428,20130402
FT402B,BHT-1-1,0.083,,ok,3.978651047,47.95854187,20130402
FT402B,BHT-1-2,20,,ok,4.023394585,48.7890892,20130402
FT402B,BHT-1-3,40,,ok,3.974789858,50.23623276,20130402
FT402B,BHT-1-4,60,,ok,3.978022099,50.31553268,20130402
FT402B,BHT-2-1,0.083,,ok,3.974560022,50.75041962,20130402
FT402B,BHT-2-2,20,,ok,3.983199596,50.36367798,20130402
FT402B,BHT-2-3,40,,ok,3.973543167,50.86017609,20130402
FT402B,BHT-2-4,60,,ok,3.976033926,51.28096771,20130402
FT402B,BHC-1-1,0.083,,ok,3.983150959,50.71032715,20130402
FT402B,BHC-1-2,20,?,REJY,3.982194424,54.32423782,20130402
FT402B,BHC-1-3,40,,ok,3.979490995,51.41252899,20130402
FT402B,BHC-1-4,60,,ok,3.98797226,48.99346542,20130402
FT402B,BHC-2-1,0.083,,ok,3.972409248,51.50766754,20130402
FT402B,BHC-2-2,20,?,REJY,3.977957487,50.49478149,20130402
FT402B,BHC-2-3,40,,ok,3.981945038,50.99291992,20130402
FT402B,BHC-2-4,60,,ok,3.989326715,52.7291832,20130402
FT402B,BLT-1-1,0.083,,ok,3.978985786,49.8676796,20130402
FT402B,BLT-1-2,20,?,REJY,3.983129978,51.92345047,20130402
FT402B,BLT-1-3,40,,ok,3.979139805,52.77097321,20130402
FT402B,BLT-1-4,60,,ok,3.983343363,51.97694016,20130402
FT402B,BLT-2-1,0.083,,ok,3.996443748,50.44508743,20130402
FT402B,BLT-2-2,20,?,REJY,3.976978302,52.34156418,20130402
FT402B,BLT-2-3,40,,ok,3.980109453,54.36909485,20130402
FT402B,BLT-2-4,60,,ok,3.999407291,51.98706818,20130402
FT402B,BLC-1-1,0.083,,ok,3.984658003,53.55729294,20130402
FT402B,BLC-1-2,20,?,REJY,3.97936511,53.05312729,20130402
FT402B,BLC-1-3,40,,ok,3.972675085,52.89146042,20130402
FT402B,BLC-1-4,60,,ok,3.986410379,51.93552399,20130402
FT402B,BLC-2-1,0.083,,ok,3.979551792,51.27191544,20130402
FT402B,BLC-2-2,20,?,REJY,3.979203939,52.8812027,20130402
FT402B,BLC-2-3,40,,ok,3.983655214,52.42316055,20130402
FT402B,BLC-2-4,60,,ok,3.984834433,54.01682281,20130402

FT402B,0.33,,CAL,ok,3.98596549,57.7134819,20130402
FT402B,0.5,,CAL,ok,3.981626511,75.41973877,20130402
FT402B,0.8,,CAL,ok,3.980276108,114.8666687,20130402
,no data,,,ok,NA,NA,
FT402C,CHK N2O,,CHK,ok,3.961376429,162.349884,20130402
FT402C,CHK CH4,,CHK,ok,0,0,20130402
FT402C,0.33,,CAL,ok,3.961949825,56.29000473,20130402
FT402C,0.5,,CAL,ok,3.969363689,74.15761566,20130402
FT402C,0.8,,CAL,ok,3.966393948,115.1910172,20130402
FT402C,CHT-1-1,0.083,,ok,3.970651388,54.2386055,20130402
FT402C,CHT-1-2,20,?,REJY,3.971689939,51.76583481,20130402
FT402C,CHT-1-3,40,,ok,3.974859953,50.57249069,20130402
FT402C,CHT-1-4,60,,ok,3.975962639,51.79261017,20130402
FT402C,CHT-2-1,0.083,,ok,3.975265265,53.33900452,20130402
FT402C,CHT-2-2,20,?,REJY,3.973003626,54.67812729,20130402
FT402C,CHT-2-3,40,,ok,3.977586746,52.72771072,20130402
FT402C,CHT-2-4,60,,ok,3.976260185,53.0333519,20130402
FT402C,CHC-1-1,0.083,,ok,3.970786572,52.34552383,20130402
FT402C,CHC-1-2,20,bad: discard,REJY,3.96877408,53.50844574,20130402
FT402C,CHC-1-3,40,,REJY,0,0,20130402
FT402C,CHC-1-4,60,,ok,3.971370459,49.33072281,20130402
FT402C,CHC-2-1,0.083,,ok,3.977923155,51.54771042,20130402
FT402C,CHC-2-2,20,bad: discard,REJY,3.972850561,50.90991592,20130402
FT402C,CHC-2-3,40,,ok,3.97909236,54.41896057,20130402
FT402C,CHC-2-4,60,,ok,3.964803219,53.86110687,20130402
FT402C,CLT-1-1,0.083,,ok,3.971289158,52.74849319,20130402
FT402C,CLT-1-2,20.5,+ 0:30,ok,3.982863903,53.51417923,20130402
FT402C,CLT-1-3,40,,ok,3.962668657,50.73791885,20130402
FT402C,CLT-1-4,60,,ok,3.971421003,52.53714371,20130402
FT402C,CLT-2-1,0.083,,ok,3.970184088,53.84638214,20130402
FT402C,CLT-2-2,20,,ok,3.974874735,51.22739792,20130402
FT402C,CLT-2-3,40,,ok,3.971123695,51.66415024,20130402
FT402C,CLT-2-4,60,,ok,3.97006464,54.23917007,20130402
FT402C,CLC-1-1,0.083,,ok,3.980540514,53.0001297,20130402
FT402C,CLC-1-2,20,,ok,3.97700119,54.63937759,20130402
FT402C,CLC-1-3,40,,ok,3.968847036,52.68437958,20130402
FT402C,CLC-1-4,60,,ok,3.973563433,52.35858536,20130402
FT402C,CLC-2-1,0.083,,ok,3.977540016,51.97822189,20130402
FT402C,CLC-2-2,20,,ok,3.979284525,51.46529388,20130402
FT402C,CLC-2-3,40,,ok,3.96850419,53.40073013,20130402
FT402C,CLC-2-4,60,,ok,3.974473476,51.97422409,20130402
FT402C,0.33,,CAL,ok,3.972979784,59.30135727,20130402
FT402C,0.5,,CAL,ok,3.967503548,80.12838745,20130402
FT402C,0.8,,CAL,ok,3.973830223,113.5252151,20130402
FT402C,CHC-1-3,40,first time analysis of skipped sample (#16),ok,3.981181383,49.16583633,20130402
FT403A,CHK N2O,,CHK,ok,3.971621037,159.3569336,20130403
FT403A,CHK CH4,,CHK,ok,0,0,20130403
FT403A,0.33,,CAL,ok,3.970381737,55.23384476,20130403
FT403A,0.5,,CAL,ok,3.973871469,74.11482239,20130403
FT403A,0.8,,CAL,ok,3.972025871,111.9215775,20130403
FT403A,AHT-1-1,0.083,,ok,3.970802546,52.79729462,20130403
FT403A,AHT-1-2,20,,ok,3.974122286,54.40321732,20130403
FT403A,AHT-1-3,40,,ok,3.967087746,52.67607498,20130403
FT403A,AHT-1-4,60,,ok,3.979008913,53.0843811,20130403
FT403A,AHT-2-1,0.083,,ok,3.976504326,54.86863708,20130403
FT403A,AHT-2-2,20,,ok,3.966466427,51.68667221,20130403
FT403A,AHT-2-3,40,,ok,3.969561815,52.60041809,20130403
FT403A,AHT-2-4,60,,ok,3.965898037,51.29013443,20130403
FT403A,AHC-1-1,0.083,,ok,3.964749098,53.07917023,20130403
FT403A,AHC-1-2,20,,ok,3.974936724,52.1856041,20130403
FT403A,AHC-1-3,40,,ok,3.965548038,52.68584061,20130403
FT403A,AHC-1-4,60,,ok,3.958919048,54.50395966,20130403

FT403A,AHC-2-1,0.083,,ok,3.960305691,53.63448334,20130403
FT403A,AHC-2-2,20,,ok,3.98677659,53.25901413,20130403
FT403A,AHC-2-3,40,,ok,3.959350586,53.63896561,20130403
FT403A,AHC-2-4,60,,ok,3.974925518,53.50327301,20130403
FT403A,ALT-1-1,0.083,,ok,3.964176893,52.70957947,20130403
FT403A,ALT-1-2,20,,ok,3.973610878,53.42998123,20130403
FT403A,ALT-1-3,40,,ok,3.971145391,53.27790451,20130403
FT403A,ALT-1-4,60,,ok,3.966571808,55.57158279,20130403
FT403A,ALT-2-1,0.083,,ok,3.959193945,53.15229416,20130403
FT403A,ALT-2-2,20,,ok,3.976410151,52.44288635,20130403
FT403A,ALT-2-3,40,,ok,3.969121218,54.61989975,20130403
FT403A,ALT-2-4,60,,ok,3.976241112,52.0084343,20130403
FT403A,ALC-1-1,0.083,,ok,3.96940279,53.62809753,20130403
FT403A,ALC-1-2,20,,ok,3.960723877,53.31916809,20130403
FT403A,ALC-1-3,40,,ok,3.965983391,53.19559097,20130403
FT403A,ALC-1-4,60,,ok,3.963996172,54.05208588,20130403
FT403A,ALC-2-1,0.083,,ok,3.9783957,53.30116653,20130403
FT403A,ALC-2-2,20,,ok,3.965032101,51.10336685,20130403
FT403A,ALC-2-3,40,,ok,3.969288349,52.43182755,20130403
FT403A,ALC-2-4,60,,ok,3.972311497,52.65498352,20130403
FT403A,0.33,,CAL,ok,3.969483137,58.3583374,20130403
FT403A,0.5,,CAL,ok,3.962825537,77.53562927,20130403
FT403A,0.8,,CAL,ok,3.970409393,108.8265457,20130403
,no data,,,ok,NA,NA,
FT403B,CHK N2O,,CHK,ok,3.984486103,162.8504639,20130403
FT403B,CHK CH4,,CHK,ok,0,0,20130403
FT403B,0.33,,CAL,ok,3.995602131,58.33614731,20130403
FT403B,0.5,,CAL,ok,3.991305828,76.71827698,20130403
FT403B,0.8,,CAL,ok,3.993531704,109.4791718,20130403
FT403B,BHT-1-1,0.083,,ok,3.987577915,51.16096878,20130403
FT403B,BHT-1-2,20,,ok,3.989280939,51.57000351,20130403
FT403B,BHT-1-3,40,,ok,3.991968155,52.67630005,20130403
FT403B,BHT-1-4,60,,ok,3.995750904,48.19036484,20130403
FT403B,BHT-2-1,0.083,,ok,3.994437456,52.21813965,20130403
FT403B,BHT-2-2,20,,ok,3.989082098,52.20284271,20130403
FT403B,BHT-2-3,40,,ok,3.990275383,51.24938583,20130403
FT403B,BHT-2-4,60,,ok,3.98829484,51.17365646,20130403
FT403B,BHC-1-1,0.083,,ok,3.988129377,48.68083572,20130403
FT403B,BHC-1-2,20,,ok,3.990952253,51.42754364,20130403
FT403B,BHC-1-3,40,,ok,3.991321802,50.19004822,20130403
FT403B,BHC-1-4,60,,ok,3.991816282,48.24826813,20130403
FT403B,BHC-2-1,0.083,,ok,3.993562698,51.33022308,20130403
FT403B,BHC-2-2,20,,ok,3.998918295,50.69924545,20130403
FT403B,BHC-2-3,40,,ok,3.982486486,49.82368851,20130403
FT403B,BHC-2-4,60,,ok,3.990073919,51.4412117,20130403
FT403B,BLT-1-1,0.083,,ok,3.976957321,50.26376343,20130403
FT403B,BLT-1-2,20,,ok,3.991113663,52.54615021,20130403
FT403B,BLT-1-3,40,,ok,3.989044189,52.50032425,20130403
FT403B,BLT-1-4,60,,ok,3.986533642,51.05454254,20130403
FT403B,BLT-2-1,0.083,,ok,3.993799686,50.02156448,20130403
FT403B,BLT-2-2,20,,ok,3.987577438,55.45706177,20130403
FT403B,BLT-2-3,40,,ok,3.994720697,57.81645966,20130403
FT403B,BLT-2-4,60,,ok,3.989895105,56.56468964,20130403
FT403B,BLC-1-1,0.083,,ok,3.99279213,52.26821136,20130403
FT403B,BLC-1-2,20,,ok,3.986348152,51.95654297,20130403
FT403B,BLC-1-3,40,,ok,3.985812664,51.43883514,20130403
FT403B,BLC-1-4,60,,ok,3.987197876,50.70999146,20130403
FT403B,BLC-2-1,0.083,,ok,3.98683548,50.34041977,20130403
FT403B,BLC-2-2,20,,ok,3.995910406,51.87812805,20130403
FT403B,BLC-2-3,40,,ok,3.991137981,51.66573334,20130403
FT403B,BLC-2-4,60,,ok,4.001536369,51.79979324,20130403
FT403B,0.33,,CAL,ok,3.998152494,56.47478867,20130403

FT403B,0.5,,CAL,ok,3.992666721,78.34165955,20130403
FT403B,0.8,,CAL,ok,3.985880136,112.0907364,20130403
,no data,,,ok,NA,NA,
FT403C,CHK N2O,,CHK,REJY,0,0,20130403
FT403C,CHK CH4,,CHK,ok,0,0,20130403
FT403C,0.33,,CAL,ok,3.989164114,56.49458313,20130403
FT403C,0.5,,CAL,ok,3.986216307,80.98375702,20130403
FT403C,0.8,,CAL,ok,3.988688231,116.4281311,20130403
FT403C,CHT-1-1,0.083,,ok,3.995355129,52.23156357,20130403
FT403C,CHT-1-2,20,,ok,3.982586145,54.07906342,20130403
FT403C,CHT-1-3,40,,ok,3.98115325,51.71668243,20130403
FT403C,CHT-1-4,60,,ok,3.991068125,51.91741943,20130403
FT403C,CHT-2-1,0.083,,ok,3.990896702,53.54821396,20130403
FT403C,CHT-2-2,20,,ok,3.977148533,52.95626068,20130403
FT403C,CHT-2-3,40,low suck,ok,3.983782291,52.92394638,20130403
FT403C,CHT-2-4,60,,ok,3.986651659,51.54752731,20130403
FT403C,CHC-1-1,0.083,"cover 20s late, adjust others",ok,3.986301661,52.90698242,20130403
FT403C,CHC-1-2,19.667,,ok,3.989026546,53.9679184,20130403
FT403C,CHC-1-3,39.667,,ok,3.977956295,53.20649338,20130403
FT403C,CHC-1-4,59.667,low suck,ok,3.990384817,54.73763657,20130403
FT403C,CHC-2-1,0.083,,ok,3.976686716,54.71844101,20130403
FT403C,CHC-2-2,20,,ok,3.984195471,56.27479553,20130403
FT403C,CHC-2-3,40,,ok,3.990579128,56.4439621,20130403
FT403C,CHC-2-4,60,,ok,3.989046574,57.93250275,20130403
FT403C,CLT-1-1,0.083,,ok,3.985476732,53.40417099,20130403
FT403C,CLT-1-2,20,,ok,3.985383272,50.88594055,20130403
FT403C,CLT-1-3,40,,ok,3.990703821,52.09495544,20130403
FT403C,CLT-1-4,60,,ok,3.981215,51.79151917,20130403
FT403C,CLT-2-1,0.083,,ok,3.9896698,50.88312531,20130403
FT403C,CLT-2-2,20,,ok,3.994125843,54.50444412,20130403
FT403C,CLT-2-3,40,,ok,3.984973907,53.6807785,20130403
FT403C,CLT-2-4,60,,ok,3.981459856,53.04432678,20130403
FT403C,CLC-1-1,0.083,,ok,3.993773699,54.59140778,20130403
FT403C,CLC-1-2,20,,ok,3.981163025,52.06139755,20130403
FT403C,CLC-1-3,40,,ok,3.987482309,50.3197937,20130403
FT403C,CLC-1-4,60,,ok,3.983883381,55.23149109,20130403
FT403C,CLC-2-1,0.083,,ok,3.988249302,54.8040657,20130403
FT403C,CLC-2-2,20,,ok,3.990989447,51.75790405,20130403
FT403C,CLC-2-3,40,,ok,3.980261326,52.73216629,20130403
FT403C,CLC-2-4,60,,ok,3.987537146,52.62643051,20130403
FT403C,0.33,,CAL,ok,3.988970995,56.79146194,20130403
FT403C,0.5,,CAL,ok,3.987500429,76.84210968,20130403
FT403C,0.8,,CAL,ok,3.981463194,109.5645905,20130403
,no data,,,ok,NA,NA,
FT404A,CHK N2O,,CHK,ok,3.975476027,167.5524445,20130404
FT404A,CHK CH4,,CHK,ok,0,0,20130404
FT404A,0.33,,CAL,ok,3.965022802,55.31645966,20130404
FT404A,0.5,,CAL,ok,3.979777336,76.79333496,20130404
FT404A,0.8,,CAL,ok,3.982444525,109.7739258,20130404
FT404A,AHT-1-1,0.083,,ok,3.985918522,52.06541824,20130404
FT404A,AHT-1-2,20,,ok,3.982351065,54.44974136,20130404
FT404A,AHT-1-3,40,,ok,3.982465982,53.57427216,20130404
FT404A,AHT-1-4,60,,ok,3.976963282,52.44729614,20130404
FT404A,AHT-2-1,0.083,,ok,3.982030153,54.13937759,20130404
FT404A,AHT-2-2,20,,ok,3.981125832,52.31687927,20130404
FT404A,AHT-2-3,40,,ok,3.985669136,52.74268723,20130404
FT404A,AHT-2-4,60,,ok,3.984193563,53.75989914,20130404
FT404A,AHC-1-1,0.083,,ok,3.983704329,52.56858444,20130404
FT404A,AHC-1-2,20,,ok,3.986039639,52.23479462,20130404
FT404A,AHC-1-3,40,,ok,3.980690479,53.70669937,20130404
FT404A,AHC-1-4,60,,ok,3.988540888,51.62466431,20130404
FT404A,AHC-2-1,0.083,,ok,3.982641459,53.45792007,20130404

FT404A,AHC-2-2,20,,ok,3.980307817,52.17364883,20130404
FT404A,AHC-2-3,40,,ok,3.984542847,51.02984238,20130404
FT404A,AHC-2-4,60,,ok,3.956146002,51.73574829,20130404
FT404A,ALT-1-1,0.083,,ok,3.982732773,52.44895935,20130404
FT404A,ALT-1-2,20,,ok,3.982100725,54.62614822,20130404
FT404A,ALT-1-3,40,,ok,3.97581172,54.07296753,20130404
FT404A,ALT-1-4,60,,ok,3.985126257,53.08312607,20130404
FT404A,ALT-2-1,0.083,,ok,3.988663673,53.69243622,20130404
FT404A,ALT-2-2,20,,ok,3.984145164,54.3283844,20130404
FT404A,ALT-2-3,40,,ok,3.967134953,52.60408783,20130404
FT404A,ALT-2-4,60,,ok,3.984250069,53.78967285,20130404
FT404A,ALC-1-1,0.083,,ok,3.951405525,51.24773407,20130404
FT404A,ALC-1-2,20,,ok,3.999386072,53.60708618,20130404
FT404A,ALC-1-3,40,,ok,3.981589556,51.50704575,20130404
FT404A,ALC-1-4,60,,ok,3.991554976,53.78922653,20130404
FT404A,ALC-2-1,0.083,,ok,3.988029957,52.44958496,20130404
FT404A,ALC-2-2,20,,REJY,0,0,20130404
,no data,,,ok,NA,NA,
FT404A,ALC-2-3,40,,ok,3.970091581,49.71536636,20130404
FT404A,ALC-2-4,60,,ok,3.992722511,50.2642746,20130404
FT404A,0.33,,CAL,ok,3.976529121,56.62202835,20130404
FT404A,0.5,,CAL,ok,3.979759932,77.14646149,20130404
FT404A,0.8,,CAL,ok,3.991619825,106.9832916,20130404
FT404B,CHK N2O,,CHK,ok,3.977455854,158.9299316,20130404
FT404B,CHK CH4,,CHK,ok,0,0,20130404
FT404B,0.33,,CAL,ok,3.986733913,54.28375244,20130404
FT404B,0.5,,CAL,ok,3.979165077,72.79021454,20130404
FT404B,0.8,,CAL,ok,3.987025976,110.4211655,20130404
FT404B,BHT-1-1,0.083,,ok,3.989027977,52.6627121,20130404
FT404B,BHT-1-2,20,,ok,3.974218369,53.30604553,20130404
FT404B,BHT-1-3,40,,ok,3.973558426,52.30573273,20130404
FT404B,BHT-1-4,60,,ok,3.980942965,52.64583588,20130404
FT404B,BHT-2-1,0.083,,ok,3.989628315,51.22187805,20130404
FT404B,BHT-2-2,20,,ok,3.988839149,51.10271072,20130404
FT404B,BHT-2-3,40,,ok,3.987083912,52.8118782,20130404
FT404B,BHT-2-4,60,,ok,3.986891031,52.64948273,20130404
FT404B,BHC-1-1,0.083,,ok,3.979982615,50.62874222,20130404
FT404B,BHC-1-2,20,,ok,3.988688469,53.28818893,20130404
FT404B,BHC-1-3,40,,ok,3.980901241,53.25229263,20130404
FT404B,BHC-1-4,60,,ok,3.976303101,51.25385666,20130404
FT404B,BHC-2-1,0.083,,ok,3.974524736,52.77445602,20130404
FT404B,BHC-2-2,20,,ok,3.975734234,52.66706467,20130404
FT404B,BHC-2-3,40,,ok,3.999816418,50.82980347,20130404
FT404B,BHC-2-4,60,,ok,3.972706079,51.01145935,20130404
FT404B,BLT-1-1,0.083,,ok,3.978439569,50.85458755,20130404
FT404B,BLT-1-2,20,,ok,3.97569561,50.89406586,20130404
FT404B,BLT-1-3,40,,ok,3.977696657,53.4302597,20130404
FT404B,BLT-1-4,60,,ok,3.981169701,53.6087532,20130404
FT404B,BLT-2-1,0.083,,ok,3.981333733,51.5847435,20130404
FT404B,BLT-2-2,20,,ok,3.976528406,62.82125473,20130404
FT404B,BLT-2-3,40,,ok,3.974976778,70.22439575,20130404
FT404B,BLT-2-4,60,,ok,3.975373745,76.691185,20130404
FT404B,BLC-1-1,0.083,,ok,3.961037397,50.29452133,20130404
FT404B,BLC-1-2,20,,ok,3.982645988,52.15916824,20130404
FT404B,BLC-1-3,40,,ok,3.982280493,52.71677399,20130404
FT404B,BLC-1-4,60,,ok,3.974873304,52.74822998,20130404
FT404B,BLC-2-1,0.083,,ok,3.984451294,50.9485321,20130404
FT404B,BLC-2-2,20,,ok,3.98180294,52.30667114,20130404
FT404B,BLC-2-3,40,,ok,3.9666574,53.31375504,20130404
FT404B,BLC-2-4,60,,ok,3.982826233,53.42596817,20130404
FT404B,0.33,,CAL,ok,3.969434023,56.99521255,20130404
FT404B,0.5,,CAL,ok,3.978631735,72.7851181,20130404

FT404B,0.8,,CAL,ok,3.974991798,105.9618378,20130404
,no data,,,ok,NA,NA,
FT404C,CHK N2O,,CHK,ok,3.979703903,159.6412659,20130404
FT404C,CHK CH4,,CHK,ok,0,0,20130404
FT404C,0.33,,CAL,ok,3.980873823,53.80708694,20130404
FT404C,0.5,,CAL,ok,3.986041307,72.49300385,20130404
FT404C,0.8,,CAL,ok,3.980923653,100.7168427,20130404
FT404C,CHT-1-1,0.083,,ok,3.989785671,48.69821167,20130404
FT404C,CHT-1-2,20,,ok,3.978827238,47.68933487,20130404
FT404C,CHT-1-3,40,,ok,3.987398148,48.6558342,20130404
FT404C,CHT-1-4,60,,ok,3.982062817,48.43791962,20130404
FT404C,CHT-2-1,0.083,,ok,3.991493225,49.13708878,20130404
FT404C,CHT-2-2,20,,ok,3.986764908,47.95810699,20130404
FT404C,CHT-2-3,40,,ok,3.988032579,47.94304276,20130404
FT404C,CHT-2-4,60,,ok,3.976608753,49.33442688,20130404
FT404C,CHC-1-1,0.083,,ok,3.985278606,47.6392746,20130404
FT404C,CHC-1-2,20,,ok,3.978448391,49.60351181,20130404
FT404C,CHC-1-3,40,,ok,3.991413116,49.0973587,20130404
FT404C,CHC-1-4,60,,ok,3.989771843,50.04250336,20130404
FT404C,CHC-2-1,0.083,,ok,3.979520321,49.21388245,20130404
FT404C,CHC-2-2,20,,ok,3.982044458,51.03007126,20130404
FT404C,CHC-2-3,40,,ok,3.984275341,55.03380966,20130404
FT404C,CHC-2-4,60,,ok,3.978799105,53.70152664,20130404
FT404C,CLT-1-1,0.083,,ok,3.9703269,48.82854843,20130404
FT404C,CLT-1-2,20,,ok,3.984271288,50.010952,20130404
FT404C,CLT-1-3,40,,ok,3.974693775,49.40299225,20130404
FT404C,CLT-1-4,60,,REJY,0,0,20130404
FT404C,CLT-2-1,0.083,,REJY,0,0,20130404
FT404C,CLT-2-2,20,,ok,3.9807446,48.0858345,20130404
FT404C,CLT-2-3,40,,ok,3.982092381,51.0389595,20130404
FT404C,CLT-2-4,60,,ok,3.978215218,51.84096909,20130404
FT404C,CLC-1-1,0.083,,ok,3.980284929,50.3032074,20130404
FT404C,CLC-1-2,20,,ok,3.987775564,49.38018417,20130404
FT404C,CLC-1-3,40,,ok,3.977772713,51.08962631,20130404
FT404C,CLC-1-4,60,,ok,3.976889849,49.01687622,20130404
FT404C,CLC-2-1,0.083,,ok,3.987334013,49.13296509,20130404
FT404C,CLC-2-2,20,,ok,3.985817194,49.68144608,20130404
FT404C,CLC-2-3,40,,ok,3.977438927,51.27250671,20130404
FT404C,CLC-2-4,60,,ok,3.98012352,51.01931381,20130404
FT404C,0.33,,CAL,ok,3.97325778,54.22904205,20130404
FT404C,0.5,,CAL,ok,3.97559309,76.01416779,20130404
FT404C,0.8,,CAL,ok,3.980772018,107.746254,20130404
,no data,,,ok,NA,NA,
FT405A,CHK N2O,,CHK,ok,3.968883514,161.72966,20130405
FT405A,CHK CH4,,CHK,ok,0,0,20130405
FT405A,0.33,,CAL,ok,3.970519066,51.29185104,20130405
FT405A,0.5,,CAL,ok,3.973883629,69.42562866,20130405
FT405A,0.8,,CAL,ok,4.006175995,98.9320755,20130405
FT405A,AHT-1-1,0.083,,ok,3.978295803,47.4022789,20130405
FT405A,AHT-1-2,20,,ok,3.97187829,50.21375275,20130405
FT405A,AHT-1-3,40,,ok,3.975997925,50.96214294,20130405
FT405A,AHT-1-4,60,,ok,3.968782425,50.57335663,20130405
FT405A,AHT-2-1,0.083,,ok,3.97950983,51.88940811,20130405
FT405A,AHT-2-2,20,,ok,3.962868929,51.03124619,20130405
FT405A,AHT-2-3,40,,ok,3.982969284,53.93885803,20130405
FT405A,AHT-2-4,60,,ok,3.97796154,52.02161789,20130405
FT405A,AHC-1-1,0.083,,ok,3.985591412,51.03500366,20130405
FT405A,AHC-1-2,20,,ok,3.973187923,52.06687927,20130405
FT405A,AHC-1-3,40,,ok,3.972471952,53.35812759,20130405
FT405A,AHC-1-4,60,,ok,3.977227211,50.5693779,20130405
FT405A,AHC-2-1,0.083,,ok,3.973488569,49.83448029,20130405
FT405A,AHC-2-2,20,,ok,3.99138546,51.00884247,20130405

FT405A,AHC-2-3,40,,ok,3.97682786,51.62159729,20130405
FT405A,AHC-2-4,60,,ok,3.971485376,53.08812714,20130405
FT405A,ALT-1-1,0.083,,ok,3.976540565,50.61838531,20130405
FT405A,ALT-1-2,20,,ok,3.978045702,49.4297142,20130405
FT405A,ALT-1-3,40,,ok,3.971216202,52.61354446,20130405
FT405A,ALT-1-4,60,,ok,3.973101854,54.01039886,20130405
FT405A,ALT-2-1,0.083,,ok,3.978863478,50.88354492,20130405
FT405A,ALT-2-2,20,,ok,3.97168541,50.9409523,20130405
FT405A,ALT-2-3,40,,ok,3.977076292,53.78750229,20130405
FT405A,ALT-2-4,60,,ok,3.950340033,53.19680405,20130405
FT405A,ALC-1-1,0.083,,ok,3.978262901,53.71406555,20130405
FT405A,ALC-1-2,20,,ok,3.975863457,54.04735184,20130405
FT405A,ALC-1-3,40,,ok,3.974827051,50.96531677,20130405
FT405A,ALC-1-4,60,,ok,3.976270199,52.78750229,20130405
FT405A,ALC-2-1,0.083,,ok,3.975695372,51.40293884,20130405
FT405A,ALC-2-2,20,,ok,3.974664211,52.9916687,20130405
FT405A,ALC-2-3,40,,ok,3.973972321,53.61811447,20130405
FT405A,ALC-2-4,60,,ok,3.975086212,51.27729416,20130405
FT405A,0.33,,CAL,ok,3.977302551,54.07458496,20130405
FT405A,0.5,,CAL,ok,3.976125956,71.5528183,20130405
FT405A,0.8,,CAL,ok,3.984059572,105.3645096,20130405
,no data,,,ok,NA,NA,
FT405B,CHK N2O,,CHK,ok,3.969685316,159.2926636,20130405
FT405B,CHK CH4,,CHK,ok,0,0,20130405
FT405B,0.33,,CAL,ok,3.970183849,55.74666977,20130405
FT405B,0.5,,CAL,ok,3.969840765,71.64886475,20130405
FT405B,0.8,,CAL,ok,3.970855236,104.1642609,20130405
FT405B,BHT-1-1,0.083,,ok,3.968684912,47.90786743,20130405
FT405B,BHT-1-2,20,,ok,3.972019672,46.15467453,20130405
FT405B,BHT-1-3,40,,ok,3.975506306,47.41129303,20130405
FT405B,BHT-1-4,60,low suck,ok,3.971834183,50.36023331,20130405
FT405B,BHT-2-1,0.083,,ok,3.974608183,48.44525528,20130405
FT405B,BHT-2-2,20,,ok,3.967803955,47.81604385,20130405
FT405B,BHT-2-3,40,,ok,3.969478846,48.56308746,20130405
FT405B,BHT-2-4,60,,ok,3.962209463,50.28052139,20130405
FT405B,BHC-1-1,0.083,,ok,3.972109079,50.57091141,20130405
FT405B,BHC-1-2,20,,ok,3.971129656,50.75096512,20130405
FT405B,BHC-1-3,40,,ok,3.979494572,49.00104523,20130405
FT405B,BHC-1-4,60,,ok,3.968518019,49.1639595,20130405
FT405B,BHC-2-1,0.083,,ok,3.96904707,49.42312622,20130405
FT405B,BHC-2-2,20,,ok,3.968539715,48.07208633,20130405
FT405B,BHC-2-3,40,,ok,3.981201887,49.3458519,20130405
FT405B,BHC-2-4,60,,ok,3.974541903,49.63900375,20130405
FT405B,BLT-1-1,0.083,,ok,3.975017309,50.27364731,20130405
FT405B,BLT-1-2,20,,ok,3.97230196,50.01791763,20130405
FT405B,BLT-1-3,40,,ok,3.980784893,48.4833374,20130405
FT405B,BLT-1-4,60,,ok,3.974744797,48.37709045,20130405
FT405B,BLT-2-1,0.083,,ok,3.971431017,51.07893372,20130405
FT405B,BLT-2-2,20,,ok,3.968413353,51.06807327,20130405
FT405B,BLT-2-3,40,,ok,3.974364996,48.53489685,20130405
FT405B,BLT-2-4,60,,ok,3.972317696,53.17705154,20130405
FT405B,BLC-1-1,0.083,,ok,3.975562334,51.4360199,20130405
FT405B,BLC-1-2,20,,ok,3.972699881,49.24190521,20130405
FT405B,BLC-1-3,40,,ok,3.970816374,51.75880051,20130405
FT405B,BLC-1-4,60,,ok,3.983613729,51.29321671,20130405
FT405B,BLC-2-1,0.083,,ok,3.971956491,52.28595734,20130405
FT405B,BLC-2-2,20,,ok,3.96841526,49.8509407,20130405
FT405B,BLC-2-3,40,,ok,3.974248409,53.25909424,20130405
FT405B,BLC-2-4,60,,ok,3.983257532,49.78645706,20130405
FT405B,0.33,,CAL,ok,3.978383064,57.05203247,20130405
FT405B,0.5,,CAL,ok,3.969748497,73.9659729,20130405
FT405B,0.8,,CAL,ok,3.970448017,107.7496185,20130405

,no data,,,ok,NA,NA,
FT405C,CHK N2O,,CHK,ok,3.963808537,155.389801,20130405
FT405C,CHK CH4,,CHK,ok,0,0,20130405
FT405C,0.33,,CAL,ok,3.968858719,51.90990829,20130405
FT405C,0.5,,CAL,ok,3.971992731,70.73693848,20130405
FT405C,0.8,,CAL,ok,3.978451967,105.5666809,20130405
FT405C,CHT-1-1,0.083,,ok,3.97243762,49.55246735,20130405
FT405C,CHT-1-2,20,,ok,3.953496933,51.93094635,20130405
FT405C,CHT-1-3,40,,ok,3.963919163,50.99427414,20130405
FT405C,CHT-1-4,60,,ok,3.961419106,53.43240356,20130405
FT405C,CHT-2-1,0.083,,ok,3.971554518,53.72385788,20130405
FT405C,CHT-2-2,20,,ok,3.959006786,52.41255569,20130405
FT405C,CHT-2-3,40,,ok,3.963806391,52.82979584,20130405
FT405C,CHT-2-4,60,,ok,3.976773739,52.09075928,20130405
FT405C,CHC-1-1,0.083,,ok,3.951069117,52.35876083,20130405
FT405C,CHC-1-2,20,,ok,3.97260046,48.02789307,20130405
FT405C,CHC-1-3,40,,ok,3.981477976,51.06248856,20130405
FT405C,CHC-1-4,60,,ok,3.971740246,52.51701355,20130405
FT405C,CHC-2-1,0.083,,ok,3.976170063,51.73579788,20130405
FT405C,CHC-2-2,20,,ok,3.954370975,51.61394882,20130405
FT405C,CHC-2-3,40,,ok,3.966500044,51.38946533,20130405
FT405C,CHC-2-4,60,,ok,3.974196196,53.9037056,20130405
FT405C,CLT-1-1,0.083,,ok,3.969082832,52.61385727,20130405
FT405C,CLT-1-2,20,,ok,3.979620457,52.984272,20130405
FT405C,CLT-1-3,40,,ok,3.968184233,50.80625153,20130405
FT405C,CLT-1-4,60,,ok,3.975383759,52.12812805,20130405
FT405C,CLT-2-1,0.083,low suck,ok,3.968585253,50.53593063,20130405
FT405C,CLT-2-2,20,,ok,4.030694008,50.55189896,20130405
FT405C,CLT-2-3,40,,ok,3.979641676,52.03271103,20130405
FT405C,CLT-2-4,60,,ok,3.966339111,54.24665833,20130405
FT405C,CLC-1-1,0.083,,ok,3.967802763,52.49772263,20130405
FT405C,CLC-1-2,20,,ok,3.969394684,51.48854446,20130405
FT405C,CLC-1-3,40,,ok,3.971454144,53.66151047,20130405
FT405C,CLC-1-4,60,,ok,3.964034557,52.57977295,20130405
FT405C,CLC-2-1,0.083,,ok,3.970136642,53.95635605,20130405
FT405C,CLC-2-2,20,,ok,3.970191956,53.85896301,20130405
FT405C,CLC-2-3,40,low suck,ok,3.968465328,52.07177353,20130405
FT405C,CLC-2-4,60,,ok,3.972602606,51.48591232,20130405
FT405C,0.33,,CAL,ok,3.966453075,56.578022,20130405
FT405C,0.5,,CAL,ok,3.976518869,77.04441071,20130405
FT405C,0.8,,CAL,ok,3.972383738,104.8908386,20130405
,no data,,,ok,NA,NA,
FT406A,CHK N2O,,CHK,ok,3.961111784,166.0110474,20130406
FT406A,CHK CH4,,CHK,ok,0,0,20130406
FT406A,0.33,,CAL,ok,3.972985268,54.29773712,20130406
FT406A,0.5,,CAL,ok,3.971834898,77.89901733,20130406
FT406A,0.8,,CAL,ok,3.971400738,116.2041321,20130406
FT406A,AHT-1-1,0.083,,ok,3.971667767,49.94651794,20130406
FT406A,AHT-1-2,20,,ok,3.925970078,48.91938019,20130406
FT406A,AHT-1-3,40,,ok,3.984087706,49.93141556,20130406
FT406A,AHT-1-4,60,,ok,3.966372967,50.3202095,20130406
FT406A,AHT-2-1,0.083,,ok,3.971719503,50.34915161,20130406
FT406A,AHT-2-2,20,,ok,3.976768255,51.34416962,20130406
FT406A,AHT-2-3,40,,ok,3.973341703,49.22962189,20130406
FT406A,AHT-2-4,60,,ok,3.98360467,50.45653152,20130406
FT406A,AHC-1-1,0.083,,ok,3.971862555,50.66752243,20130406
FT406A,AHC-1-2,20,,ok,3.983110905,51.81580353,20130406
FT406A,AHC-1-3,40,,ok,3.98049593,50.03396225,20130406
FT406A,AHC-1-4,60,,ok,3.97770524,50.56628036,20130406
FT406A,AHC-2-1,0.083,,ok,3.978462934,50.16152191,20130406
FT406A,AHC-2-2,20,,ok,3.971626282,49.86281586,20130406
FT406A,AHC-2-3,40,,ok,3.972767115,51.17739868,20130406

FT406A,AHC-2-4,60,,ok,3.979371071,52.17673111,20130406
FT406A,ALT-1-1,0.083,,ok,3.962509155,51.23233795,20130406
FT406A,ALT-1-2,20,,ok,3.965652227,51.03873444,20130406
FT406A,ALT-1-3,40,,ok,3.97065258,49.33729553,20130406
FT406A,ALT-1-4,60,,ok,3.97460556,54.91337204,20130406
FT406A,ALT-2-1,0.083,,ok,3.978158951,50.78646088,20130406
FT406A,ALT-2-2,20,,ok,3.978586674,49.89729309,20130406
FT406A,ALT-2-3,40,,ok,3.978918552,53.70038223,20130406
FT406A,ALT-2-4,60,,ok,3.966032267,54.07250214,20130406
FT406A,ALC-1-1,0.083,,ok,3.975631952,51.17131805,20130406
FT406A,ALC-1-2,20,,ok,3.967872858,52.9772644,20130406
FT406A,ALC-1-3,40,,ok,3.972366571,51.93614578,20130406
FT406A,ALC-1-4,60,,ok,3.985612392,51.31052399,20130406
FT406A,ALC-2-1,0.083,,ok,3.970061302,50.02790833,20130406
FT406A,ALC-2-2,20,,ok,3.970699787,51.28769684,20130406
FT406A,ALC-2-3,40,,ok,3.978729725,52.10977936,20130406
FT406A,ALC-2-4,60,,ok,3.976489782,50.78958511,20130406
FT406A,0.33,,CAL,ok,3.99627614,54.15756226,20130406
FT406A,0.5,,CAL,ok,3.972726822,76.83922577,20130406
FT406A,0.8,,CAL,ok,3.965059996,119.1717224,20130406
,no data,,,ok,NA,NA,
FT406B,CHK N2O,,CHK,ok,3.986229897,156.1550598,20130406
FT406B,CHK CH4,,CHK,ok,0,0,20130406
FT406B,0.33,,CAL,ok,3.997418642,54.27172089,20130406
FT406B,0.5,,CAL,ok,3.987008333,75.23513031,20130406
FT406B,0.8,,CAL,ok,3.99377656,108.7128372,20130406
FT406B,BHT-1-1,0.083,cover late 0:60,ok,3.986101627,47.41753006,20130406
FT406B,BHT-1-2,19,,ok,3.974892616,49.83737183,20130406
FT406B,BHT-1-3,39,,ok,3.993677616,45.90604401,20130406
FT406B,BHT-1-4,59,,ok,3.986192942,49.2373848,20130406
FT406B,BHT-2-1,0.083,,ok,3.989901543,47.68815613,20130406
FT406B,BHT-2-2,20,,ok,3.98518157,47.56967926,20130406
FT406B,BHT-2-3,40,,ok,3.984930038,47.26722717,20130406
FT406B,BHT-2-4,60,,ok,3.987034082,47.22040558,20130406
FT406B,BHC-1-1,0.083,cover late 0:15,ok,3.984160185,47.27223969,20130406
FT406B,BHC-1-2,19.75,,ok,3.993193388,47.65179825,20130406
FT406B,BHC-1-3,39.75,,ok,3.986599922,48.38079453,20130406
FT406B,BHC-1-4,59.75,,ok,3.984661341,49.02767181,20130406
FT406B,BHC-2-1,0.083,,ok,3.987115383,46.89775085,20130406
FT406B,BHC-2-2,20,,ok,3.99617815,49.68412781,20130406
FT406B,BHC-2-3,40,,ok,3.983962059,52.45004654,20130406
FT406B,BHC-2-4,60,,ok,3.986393929,47.63917542,20130406
FT406B,BLT-1-1,0.083,,ok,3.989328861,48.85687637,20130406
FT406B,BLT-1-2,20,,ok,3.984183788,49.27800369,20130406
FT406B,BLT-1-3,40,,ok,3.989423275,52.71574783,20130406
FT406B,BLT-1-4,60,,ok,3.9842062,52.87166595,20130406
FT406B,BLT-2-1,0.083,,ok,3.992175341,49.2990036,20130406
FT406B,BLT-2-2,20,,ok,3.989850521,51.84646225,20130406
FT406B,BLT-2-3,40,,ok,3.979190111,52.73258972,20130406
FT406B,BLT-2-4,60,,ok,3.990688562,54.98050308,20130406
FT406B,BLC-1-1,0.083,,ok,3.983646631,49.69752884,20130406
FT406B,BLC-1-2,20,,ok,3.989654064,51.96708679,20130406
FT406B,BLC-1-3,40,,ok,3.993677616,52.88476563,20130406
FT406B,BLC-1-4,60,,ok,3.980103731,51.39455414,20130406
FT406B,BLC-2-1,0.083,,ok,3.980751276,49.74214554,20130406
FT406B,BLC-2-2,20,,ok,3.989540577,47.79393768,20130406
FT406B,BLC-2-3,40,,ok,3.985582113,49.23810577,20130406
FT406B,BLC-2-4,60,,ok,3.983844519,49.48585129,20130406
FT406B,0.33,,CAL,ok,3.989147425,52.96053696,20130406
FT406B,0.5,,CAL,ok,3.987758636,77.87949371,20130406
FT406B,0.8,,CAL,ok,3.980558395,113.2661972,20130406
,no data,,,ok,NA,NA,

FT406C,CHK N2O,,CHK,ok,3.983595848,156.802597,20130406
FT406C,CHK CH4,,CHK,ok,0,0,20130406
FT406C,0.33,,CAL,ok,3.98465848,55.31562042,20130406
FT406C,0.5,,CAL,ok,3.974722147,76.17208862,20130406
FT406C,0.8,,CAL,ok,3.974580765,115.6362457,20130406
FT406C,CHT-1-1,0.083,,ok,3.986568451,51.12877274,20130406
FT406C,CHT-1-2,20,,ok,3.96323967,51.25127029,20130406
FT406C,CHT-1-3,40,,ok,3.980784893,51.14551544,20130406
FT406C,CHT-1-4,60,,ok,3.983641148,51.95864868,20130406
FT406C,CHT-2-1,0.083,,ok,3.99653697,53.12733459,20130406
FT406C,CHT-2-2,20,,ok,3.98291564,51.77495193,20130406
FT406C,CHT-2-3,40,,ok,3.986518145,54.78223419,20130406
FT406C,CHT-2-4,60,,ok,3.984097958,51.62573624,20130406
FT406C,CHC-1-1,0.083,,ok,3.976477146,51.31583786,20130406
FT406C,CHC-1-2,20,,ok,3.979140997,51.86604309,20130406
FT406C,CHC-1-3,40,,ok,3.972173214,48.32041931,20130406
FT406C,CHC-1-4,60,,ok,3.962154388,52.47884369,20130406
FT406C,CHC-2-1,0.083,,ok,3.979157448,52.0963707,20130406
FT406C,CHC-2-2,20,,ok,3.984226227,52.20972061,20130406
FT406C,CHC-2-3,40,not sure ?,REJY,3.985257626,51.79921722,20130406
FT406C,CHC-2-4,60,,ok,3.980934143,53.19041824,20130406
FT406C,CLT-1-1,0.083,,ok,3.988406181,51.41354752,20130406
FT406C,CLT-1-2,20,,ok,3.97860074,51.12934875,20130406
FT406C,CLT-1-3,40.25,0:15 late,ok,3.985776663,53.49861526,20130406
FT406C,CLT-1-4,60,,ok,3.988159418,50.72382736,20130406
FT406C,CLT-2-1,0.083,,ok,3.982666254,49.88702393,20130406
FT406C,CLT-2-2,20,,ok,3.990038872,51.8658371,20130406
FT406C,CLT-2-3,40,,ok,3.983808279,53.51364136,20130406
FT406C,CLT-2-4,60,,ok,3.988794565,53.71469116,20130406
FT406C,CLC-1-1,0.083,,ok,3.988964319,49.62989807,20130406
FT406C,CLC-1-2,20,,ok,3.998960733,50.48445511,20130406
FT406C,CLC-1-3,40,,ok,3.962977171,52.21224594,20130406
FT406C,CLC-1-4,60,,ok,3.979520321,51.41550446,20130406
FT406C,CLC-2-1,0.083,,ok,3.990780115,50.05013275,20130406
FT406C,CLC-2-2,20,,ok,3.989599228,48.72915268,20130406
FT406C,CLC-2-3,40,,ok,3.977838516,50.86653137,20130406
FT406C,CLC-2-4,60,,ok,3.989015818,53.78656387,20130406
FT406C,0.33,,CAL,ok,3.974946022,55.65725327,20130406
FT406C,0.5,,CAL,ok,3.984146357,77.04322815,20130406
FT406C,0.8,,CAL,ok,3.982445955,116.9871597,20130406
,no data,,,ok,NA,NA,
FT407A,CHK N2O,,CHK,ok,3.973345518,170.5348816,20130407
FT407A,CHK CH4,,CHK,ok,0,0,20130407
FT407A,0.33,,CAL,ok,3.978576899,56.7893219,20130407
FT407A,0.5,,CAL,ok,3.979170322,79.03216553,20130407
FT407A,0.8,,CAL,ok,3.984140873,117.3401413,20130407
FT407A,AHT-1-1,0.083,,ok,3.99339366,53.45271301,20130407
FT407A,AHT-1-2,20,,ok,3.985030174,51.33027267,20130407
FT407A,AHT-1-3,40,,ok,3.986685991,50.19375229,20130407
FT407A,AHT-1-4,60,,ok,3.988464594,52.30427551,20130407
FT407A,AHT-2-1,0.083,,ok,3.974699736,50.96450424,20130407
FT407A,AHT-2-2,20,,ok,3.997078419,52.70081711,20130407
FT407A,AHT-2-3,40,,ok,3.989728451,52.56760788,20130407
FT407A,AHT-2-4,60,,ok,3.979536772,51.83037567,20130407
FT407A,AHC-1-1,0.083,,ok,3.98242116,50.51649475,20130407
FT407A,AHC-1-2,20,,ok,4.002910614,54.51501083,20130407
FT407A,AHC-1-3,40,,ok,3.988694429,50.29927444,20130407
FT407A,AHC-1-4,60,,ok,3.975533724,49.34770966,20130407
FT407A,AHC-2-1,0.083,,ok,3.980523109,50.84802246,20130407
FT407A,AHC-2-2,20,,ok,3.992893696,51.3819809,20130407
FT407A,AHC-2-3,40,,ok,3.982249022,49.11507797,20130407
FT407A,AHC-2-4,60,,ok,3.982901096,51.18625259,20130407

FT407A,ALT-1-1,0.083,,ok,3.987909079,49.98718643,20130407
FT407A,ALT-1-2,20,,ok,3.989121437,49.15480423,20130407
FT407A,ALT-1-3,40,,ok,3.995626211,50.26021194,20130407
FT407A,ALT-1-4,60,,ok,3.975332737,53.18213272,20130407
FT407A,ALT-2-1,0.083,,ok,3.9955163,50.54731369,20130407
FT407A,ALT-2-2,20,,ok,3.986747742,51.93001938,20130407
FT407A,ALT-2-3,40,,ok,3.988153458,51.64327621,20130407
FT407A,ALT-2-4,60,,ok,3.986857414,50.91676331,20130407
FT407A,ALC-1-1,0.083,,ok,3.990515947,52.34833527,20130407
FT407A,ALC-1-2,20,,ok,3.982662439,49.8983345,20130407
FT407A,ALC-1-3,40,,ok,3.982032299,53.04565048,20130407
FT407A,ALC-1-4,60,,ok,3.981139898,53.1875,20130407
FT407A,ALC-2-1,0.083,,ok,3.98506999,51.95884705,20130407
FT407A,ALC-2-2,20,,ok,3.982728243,53.19135666,20130407
FT407A,ALC-2-3,40,,ok,3.984479427,50.91666794,20130407
FT407A,ALC-2-4,60,,ok,3.989935398,52.031147,20130407
FT407A,0.33,,CAL,ok,3.993649483,54.85055161,20130407
FT407A,0.5,,CAL,ok,3.983324051,79.20446014,20130407
FT407A,0.8,,CAL,ok,3.98451972,116.5658035,20130407
,no data,,,ok,NA,NA,
FT407B,CHK N2O,,CHK,ok,3.981327057,158.1448059,20130407
FT407B,CHK CH4,,CHK,ok,0,0,20130407
FT407B,0.33,,CAL,ok,3.983754158,54.58490372,20130407
FT407B,0.5,,CAL,ok,3.983537674,73.46832275,20130407
FT407B,0.8,,CAL,ok,3.987605572,111.9050064,20130407
FT407B,BHT-1-1,0.083,,ok,3.978952408,48.42222214,20130407
FT407B,BHT-1-2,20,,ok,3.980825901,51.64312744,20130407
FT407B,BHT-1-3,40,,ok,3.968488216,53.21981812,20130407
FT407B,BHT-1-4,60,,ok,3.974565029,54.18582153,20130407
FT407B,BHT-2-1,0.083,,ok,3.97992444,52.36854553,20130407
FT407B,BHT-2-2,20,,ok,3.985894442,53.55563736,20130407
FT407B,BHT-2-3,40,,ok,3.98746109,53.44496918,20130407
FT407B,BHT-2-4,60,,ok,3.983526707,52.09754181,20130407
FT407B,BHC-1-1,0.083,,ok,3.985787392,52.84629059,20130407
FT407B,BHC-1-2,20,,ok,3.984228849,53.39458466,20130407
FT407B,BHC-1-3,40,,ok,3.975447416,52.94028854,20130407
FT407B,BHC-1-4,60,,ok,3.969279289,55.27459335,20130407
FT407B,BHC-2-1,0.083,,ok,3.979038954,49.33208084,20130407
FT407B,BHC-2-2,20,,ok,3.983652353,52.70779419,20130407
FT407B,BHC-2-3,40,,ok,3.97594142,50.13479614,20130407
FT407B,BHC-2-4,60,,ok,3.99691987,53.79781342,20130407
FT407B,BLT-1-1,0.083,,ok,3.984643698,50.96130371,20130407
FT407B,BLT-1-2,20,,ok,3.982343912,48.43089294,20130407
FT407B,BLT-1-3,40,,ok,3.974568129,52.47223663,20130407
FT407B,BLT-1-4,60,,ok,4.020741463,51.59581757,20130407
FT407B,BLT-2-1,0.083,,ok,3.984303236,53.0368042,20130407
FT407B,BLT-2-2,20,,ok,3.977492571,54.70573044,20130407
FT407B,BLT-2-3,40,,ok,3.984415293,51.77875137,20130407
FT407B,BLT-2-4,60,,ok,3.977298021,53.54938889,20130407
FT407B,BLC-1-1,0.083,,ok,3.984287262,52.79310989,20130407
FT407B,BLC-1-2,20,,ok,3.986691713,51.41692352,20130407
FT407B,BLC-1-3,40,,ok,3.990215302,51.89698029,20130407
FT407B,BLC-1-4,60,,ok,3.984909296,51.47955704,20130407
FT407B,BLC-2-1,0.083,,ok,3.982010841,53.63015747,20130407
FT407B,BLC-2-2,20,,ok,3.983134508,55.10687637,20130407
FT407B,BLC-2-3,40,,ok,3.977828264,53.38042068,20130407
FT407B,BLC-2-4,60,,ok,3.974670649,55.59208679,20130407
FT407B,0.33,,CAL,ok,3.978639126,59.03907013,20130407
FT407B,0.5,,CAL,ok,3.975943804,78.30001831,20130407
FT407B,0.8,,CAL,ok,3.982971907,116.6857376,20130407
,no data,,,ok,NA,NA,
FT407C,CHK N2O,,CHK,ok,3.965792179,162.6423645,20130407

FT407C,CHK CH4,,CHK,ok,0,0,20130407
FT407C,0.33,,CAL,REJY,0,0,20130407
FT407C,0.5,,CAL,ok,4.009696484,74.3240509,20130407
FT407C,0.8,,CAL,ok,3.97299099,118.3697433,20130407
FT407C,CHT-1-1,0.083,,ok,3.972617388,53.94656372,20130407
FT407C,CHT-1-2,20,,ok,3.957961321,54.2076416,20130407
FT407C,CHT-1-3,40,,ok,3.9674685,54.77637482,20130407
FT407C,CHT-1-4,60,,ok,3.971216679,50.58041763,20130407
FT407C,CHT-2-1,0.083,,ok,3.975116968,52.79143143,20130407
FT407C,CHT-2-2,20,,ok,3.977284908,54.01041794,20130407
FT407C,CHT-2-3,40,,ok,3.9651227,53.76416779,20130407
FT407C,CHT-2-4,60,,ok,3.98116231,53.42552185,20130407
FT407C,CHC-1-1,0.083,,ok,3.984470844,51.26623535,20130407
FT407C,CHC-1-2,20,,ok,3.999518394,50.54003906,20130407
FT407C,CHC-1-3,40,,ok,3.982732058,53.22417068,20130407
FT407C,CHC-1-4,60,,ok,3.96036005,52.65760803,20130407
FT407C,CHC-2-1,0.083,,ok,3.975717068,51.97166824,20130407
FT407C,CHC-2-2,20,,ok,3.978740454,51.15417099,20130407
FT407C,CHC-2-3,40,,ok,3.976657152,53.49446869,20130407
FT407C,CHC-2-4,60,,ok,3.981947422,52.18395996,20130407
FT407C,CLT-1-1,0.083,,ok,3.968791246,50.16356659,20130407
FT407C,CLT-1-2,20,,ok,3.966284513,51.67677307,20130407
FT407C,CLT-1-3,40,,ok,3.970842361,51.42186737,20130407
FT407C,CLT-1-4,60,,ok,3.968459368,52.2567749,20130407
FT407C,CLT-2-1,0.083,,ok,3.968489408,53.68135834,20130407
FT407C,CLT-2-2,20,,ok,3.973982334,53.74250412,20130407
FT407C,CLT-2-3,40,,ok,3.964577198,52.19338226,20130407
FT407C,CLT-2-4,60,,ok,3.965631247,52.9087944,20130407
FT407C,CLC-1-1,0.083,,ok,3.972883701,53.19511795,20130407
FT407C,CLC-1-2,20,,ok,3.944275141,52.90975571,20130407
FT407C,CLC-1-3,40,,ok,3.974517107,56.09847641,20130407
FT407C,CLC-1-4,60,,ok,3.965084553,54.66653824,20130407
FT407C,CLC-2-1,0.083,,ok,3.968548059,55.62149048,20130407
FT407C,CLC-2-2,20,,ok,3.971274614,54.15021133,20130407
FT407C,CLC-2-3,40,,ok,3.968121529,55.76135635,20130407
FT407C,CLC-2-4,60,,ok,3.968103647,54.14323044,20130407
FT407C,0.33,,CAL,ok,3.975679159,58.57623672,20130407
FT407C,0.5,,CAL,ok,3.962964296,78.76496887,20130407
FT407C,0.8,,CAL,ok,3.962144613,118.3574295,20130407
,no data,,,ok,NA,NA,

Molar volume data

This data is used to calculate fluxes using equation 1 (see paper). It presents the molar volume of an ideal gas calculated from the average air temperature and air pressure during each sampling campaign. It is loaded by script 3.

Header description:

- *"date": Date of the campaign for which each value is used to calculate fluxes.*
- *"Vm_m3_mol": Molar volume in units of* $m^3\ mol^{-1}$

```
date,Vm_m3_mol
3/27/2013,0.023796417
3/28/2013,0.023471387
3/29/2013,0.023595095
3/30/2013,0.02385484
3/31/2013,0.024129503
4/1/2013,0.023656982
4/2/2013,0.02315533
4/3/2013,0.023044509
4/4/2013,0.02381672
4/5/2013,0.023922762
4/6/2013,0.023345424
4/7/2013,0.024720983
```

Flux data

This data is from the output of script 3 and can be generated by running script 1, 2, and 3 with the Raw gas chromatography data and the Molar volume data. It can be used to run script 4, 5, and 6. Script 6 converts these fluxes to the units presented in fig. 3A of the paper.

Header description:

- *"date": Date of flux observation.*
- *"fluxL": The flux value in units of g N2O m^{-2} min^{-1}, calculated using the linear regression slope from its respective concentration vs. time plot.*
- *"ID": Code indicating the plot, topological position (Low or High), crop type, and chamber number.*

```
Date,fluxL,ID
3/27/2013,-9.15E-08,AHC1
3/27/2013,1.97E-07,AHC2
3/27/2013,-3.03E-08,AHT1
3/27/2013,3.94E-08,AHT2
3/27/2013,-1.96E-07,ALC1
3/27/2013,4.73E-08,ALC2
3/27/2013,2.89E-07,ALT1
3/27/2013,-1.73E-07,ALT2
3/27/2013,-1.17E-07,BHC1
3/27/2013,1.87E-08,BHC2
3/27/2013,3.99E-08,BHT1
3/27/2013,-1.14E-07,BHT2
3/27/2013,6.65E-08,BLC1
3/27/2013,7.21E-08,BLC2
3/27/2013,1.42E-07,BLT1
3/27/2013,2.87E-07,BLT2
3/27/2013,2.15E-07,CHC1
3/27/2013,1.01E-07,CHC2
3/27/2013,-1.70E-07,CHT1
3/27/2013,-7.54E-09,CHT2
3/27/2013,-7.42E-09,CLC1
3/27/2013,7.52E-08,CLC2
3/27/2013,3.54E-08,CLT1
3/27/2013,1.39E-07,CLT2
3/28/2013,1.25E-07,AHC1
3/28/2013,7.73E-08,AHC2
3/28/2013,1.08E-07,AHT1
3/28/2013,-6.99E-08,AHT2
3/28/2013,3.36E-08,ALC1
3/28/2013,5.45E-08,ALC2
3/28/2013,2.24E-07,ALT1
3/28/2013,6.56E-08,ALT2
3/28/2013,1.08E-07,BHC1
3/28/2013,-6.05E-08,BHC2
```

3/28/2013,1.07E-07,BHT1
3/28/2013,1.19E-07,BHT2
3/28/2013,7.31E-08,BLC1
3/28/2013,1.39E-08,BLC2
3/28/2013,1.92E-07,BLT1
3/28/2013,1.89E-07,BLT2
3/28/2013,9.81E-08,CHC1
3/28/2013,-2.16E-08,CHC2
3/28/2013,1.83E-07,CHT1
3/28/2013,1.81E-07,CHT2
3/28/2013,-4.35E-09,CLC1
3/28/2013,-3.18E-08,CLC2
3/28/2013,7.75E-08,CLT1
3/28/2013,2.08E-07,CLT2
3/29/2013,1.16E-07,AHC1
3/29/2013,1.31E-07,AHC2
3/29/2013,7.34E-08,AHT1
3/29/2013,1.44E-07,AHT2
3/29/2013,-5.26E-08,ALC1
3/29/2013,8.29E-08,ALC2
3/29/2013,-9.49E-08,ALT1
3/29/2013,1.37E-07,ALT2
3/29/2013,1.66E-07,BHC1
3/29/2013,1.26E-07,BHC2
3/29/2013,-4.11E-08,BHT1
3/29/2013,-7.43E-09,BHT2
3/29/2013,1.29E-07,BLC1
3/29/2013,-2.39E-07,BLC2
3/29/2013,1.31E-07,BLT1
3/29/2013,1.98E-07,BLT2
3/29/2013,1.44E-07,CHC1
3/29/2013,-2.73E-08,CHC2
3/29/2013,2.07E-07,CHT1
3/29/2013,2.00E-07,CHT2
3/29/2013,-1.74E-07,CLC1
3/29/2013,-5.92E-08,CLC2
3/29/2013,1.45E-07,CLT1
3/29/2013,2.30E-08,CLT2
3/30/2013,-6.25E-08,AHC1
3/30/2013,9.70E-08,AHC2
3/30/2013,5.09E-08,AHT1
3/30/2013,-9.33E-08,AHT2
3/30/2013,4.23E-08,ALC1
3/30/2013,-1.35E-07,ALC2
3/30/2013,1.82E-07,ALT1
3/30/2013,-2.74E-08,ALT2
3/30/2013,7.96E-08,BHC1
3/30/2013,-1.69E-07,BHC2
3/30/2013,7.35E-08,BHT1
3/30/2013,-1.15E-08,BHT2
3/30/2013,2.65E-07,BLC1
3/30/2013,1.01E-07,BLC2
3/30/2013,9.16E-08,BLT1
3/30/2013,1.84E-08,BLT2
3/30/2013,4.77E-08,CHC1
3/30/2013,7.72E-08,CHC2
3/30/2013,-1.08E-07,CHT1
3/30/2013,1.31E-07,CHT2
3/30/2013,4.25E-08,CLC1
3/30/2013,-1.52E-07,CLC2
3/30/2013,5.85E-08,CLT1
3/30/2013,7.11E-08,CLT2

3/31/2013,3.09E-07,AHC1
3/31/2013,6.29E-08,AHC2
3/31/2013,1.27E-07,AHT1
3/31/2013,8.68E-08,AHT2
3/31/2013,9.90E-08,ALC1
3/31/2013,-1.12E-07,ALC2
3/31/2013,8.43E-08,ALT1
3/31/2013,1.91E-07,ALT2
3/31/2013,-8.93E-08,BHC1
3/31/2013,-1.63E-08,BHC2
3/31/2013,-1.03E-07,BHT1
3/31/2013,9.09E-08,BHT2
3/31/2013,1.17E-07,BLC1
3/31/2013,3.12E-08,BLC2
3/31/2013,2.03E-08,BLT1
3/31/2013,1.96E-07,BLT2
3/31/2013,-6.47E-08,CHC1
3/31/2013,1.92E-07,CHC2
3/31/2013,5.03E-08,CHT1
3/31/2013,-1.36E-07,CHT2
3/31/2013,8.03E-08,CLC1
3/31/2013,1.65E-08,CLC2
3/31/2013,5.95E-08,CLT1
3/31/2013,3.83E-08,CLT2
4/1/2013,6.62E-08,AHC1
4/1/2013,1.54E-07,AHC2
4/1/2013,-1.91E-07,AHT1
4/1/2013,-3.45E-08,AHT2
4/1/2013,2.52E-07,ALC1
4/1/2013,-5.15E-08,ALC2
4/1/2013,8.51E-08,ALT1
4/1/2013,4.23E-08,ALT2
4/1/2013,4.80E-08,BHC1
4/1/2013,3.20E-07,BHC2
4/1/2013,1.19E-07,BHT1
4/1/2013,1.18E-07,BHT2
4/1/2013,-1.18E-07,BLC1
4/1/2013,-2.16E-07,BLC2
4/1/2013,2.46E-07,BLT1
4/1/2013,1.62E-07,BLT2
4/1/2013,-2.91E-08,CHC1
4/1/2013,-1.42E-08,CHC2
4/1/2013,-2.25E-07,CHT1
4/1/2013,9.48E-08,CHT2
4/1/2013,2.90E-08,CLC1
4/1/2013,2.46E-07,CLC2
4/1/2013,-1.64E-07,CLT1
4/1/2013,4.06E-09,CLT2
4/2/2013,7.90E-08,AHC1
4/2/2013,8.86E-08,AHC2
4/2/2013,2.34E-07,AHT1
4/2/2013,-2.14E-08,AHT2
4/2/2013,-1.23E-09,ALC1
4/2/2013,1.38E-07,ALC2
4/2/2013,-9.55E-08,ALT1
4/2/2013,-3.35E-08,ALT2
4/2/2013,-1.02E-07,BHC1
4/2/2013,7.20E-08,BHC2
4/2/2013,1.96E-07,BHT1
4/2/2013,4.82E-08,BHT2
4/2/2013,-1.18E-07,BLC1
4/2/2013,2.00E-07,BLC2

4/2/2013,1.87E-07,BLT1
4/2/2013,1.66E-07,BLT2
4/2/2013,-2.56E-07,CHC1
4/2/2013,2.04E-07,CHC2
4/2/2013,-2.26E-07,CHT1
4/2/2013,-3.08E-08,CHT2
4/2/2013,-9.14E-08,CLC1
4/2/2013,4.52E-08,CLC2
4/2/2013,-7.93E-08,CLT1
4/2/2013,3.82E-08,CLT2
4/3/2013,1.20E-07,AHC1
4/3/2013,-3.17E-10,AHC2
4/3/2013,-2.18E-08,AHT1
4/3/2013,-2.46E-07,AHT2
4/3/2013,2.88E-08,ALC1
4/3/2013,-1.51E-08,ALC2
4/3/2013,2.11E-07,ALT1
4/3/2013,-3.15E-08,ALT2
4/3/2013,-6.45E-08,BHC1
4/3/2013,-1.37E-08,BHC2
4/3/2013,-1.98E-07,BHT1
4/3/2013,-1.04E-07,BHT2
4/3/2013,-1.32E-07,BLC1
4/3/2013,1.05E-07,BLC2
4/3/2013,5.87E-08,BLT1
4/3/2013,5.57E-07,BLT2
4/3/2013,1.13E-07,CHC1
4/3/2013,2.34E-07,CHC2
4/3/2013,-7.90E-08,CHT1
4/3/2013,-1.44E-07,CHT2
4/3/2013,4.57E-09,CLC1
4/3/2013,-1.32E-07,CLC2
4/3/2013,-8.64E-08,CLT1
4/3/2013,1.35E-07,CLT2
4/4/2013,-3.41E-08,AHC1
4/4/2013,-1.58E-07,AHC2
4/4/2013,6.55E-09,AHT1
4/4/2013,-1.77E-08,AHT2
4/4/2013,1.38E-07,ALC1
4/4/2013,-2.05E-07,ALC2
4/4/2013,3.36E-08,ALT1
4/4/2013,-3.59E-08,ALT2
4/4/2013,4.50E-08,BHC1
4/4/2013,-1.75E-07,BHC2
4/4/2013,-2.59E-08,BHT1
4/4/2013,1.47E-07,BHT2
4/4/2013,1.94E-07,BLC1
4/4/2013,2.07E-07,BLC2
4/4/2013,2.65E-07,BLT1
4/4/2013,2.03E-06,BLT2
4/4/2013,1.73E-07,CHC1
4/4/2013,4.52E-07,CHC2
4/4/2013,4.88E-09,CHT1
4/4/2013,1.51E-08,CHT2
4/4/2013,-5.56E-08,CLC1
4/4/2013,1.88E-07,CLC2
4/4/2013,7.42E-08,CLT1
4/4/2013,4.85E-07,CLT2
4/5/2013,-2.91E-09,AHC1
4/5/2013,2.70E-07,AHC2
4/5/2013,2.67E-07,AHT1
4/5/2013,8.61E-08,AHT2

4/5/2013,-1.53E-07,ALC1
4/5/2013,6.30E-09,ALC2
4/5/2013,3.48E-07,ALT1
4/5/2013,2.55E-07,ALT2
4/5/2013,-1.55E-07,BHC1
4/5/2013,5.01E-08,BHC2
4/5/2013,2.24E-07,BHT1
4/5/2013,1.63E-07,BHT2
4/5/2013,5.45E-08,BLC1
4/5/2013,-1.06E-07,BLC2
4/5/2013,-1.88E-07,BLT1
4/5/2013,9.79E-08,BLT2
4/5/2013,8.93E-08,CHC1
4/5/2013,1.59E-07,CHC2
4/5/2013,2.71E-07,CHT1
4/5/2013,-1.13E-07,CHT2
4/5/2013,6.13E-08,CLC1
4/5/2013,-2.33E-07,CLC2
4/5/2013,-9.21E-08,CLT1
4/5/2013,3.20E-07,CLT2
4/6/2013,-4.39E-08,AHC1
4/6/2013,1.55E-07,AHC2
4/6/2013,4.49E-08,AHT1
4/6/2013,-3.77E-08,AHT2
4/6/2013,-1.32E-08,ALC1
4/6/2013,6.52E-08,ALC2
4/6/2013,1.96E-07,ALT1
4/6/2013,2.87E-07,ALT2
4/6/2013,1.40E-07,BHC1
4/6/2013,1.16E-07,BHC2
4/6/2013,3.49E-08,BHT1
4/6/2013,-3.97E-08,BHT2
4/6/2013,1.40E-07,BLC1
4/6/2013,1.59E-08,BLC2
4/6/2013,3.60E-07,BLT1
4/6/2013,4.17E-07,BLT2
4/6/2013,-1.18E-09,CHC1
4/6/2013,8.37E-08,CHC2
4/6/2013,5.21E-08,CHT1
4/6/2013,-3.27E-08,CHT2
4/6/2013,1.55E-07,CLC1
4/6/2013,2.92E-07,CLC2
4/6/2013,7.49E-09,CLT1
4/6/2013,2.87E-07,CLT2
4/7/2013,-1.60E-07,AHC1
4/7/2013,-2.59E-08,AHC2
4/7/2013,-9.45E-08,AHT1
4/7/2013,5.08E-08,AHT2
4/7/2013,1.17E-07,ALC1
4/7/2013,-4.26E-08,ALC2
4/7/2013,2.21E-07,ALT1
4/7/2013,1.69E-08,ALT2
4/7/2013,1.47E-07,BHC1
4/7/2013,2.33E-07,BHC2
4/7/2013,4.07E-07,BHT1
4/7/2013,-2.00E-08,BHT2
4/7/2013,-7.46E-08,BLC1
4/7/2013,8.97E-08,BLC2
4/7/2013,1.28E-07,BLT1
4/7/2013,-3.00E-08,BLT2
4/7/2013,1.39E-07,CHC1
4/7/2013,6.05E-08,CHC2

4/7/2013,-1.94E-07,CHT1
4/7/2013,3.36E-08,CHT2
4/7/2013,1.55E-07,CLC1
4/7/2013,-5.73E-08,CLC2
4/7/2013,1.22E-07,CLT1
4/7/2013,-7.86E-08,CLT2

Above-ground biomass data

This data presents the measured above-ground biomass of each chamber. It is plotted in fig. 4 and 5 in the paper. It is not used by the scripts presented in this document.

Header description:

- *"ID": Code indicating the plot (A, B or C), topological position (Low or High), crop type (RCG or FGL), and chamber number (1 or 2) from which the material was gathered.*
- *"total_dry_g": The amount of dry above-ground biomass in grams.*

```
ID,total_dry_g
AHT-1,24.0039604
AHT-2,11.34609375
AHC-1,56.8627451
AHC-2,60.71428571
ALT-1,24.15813953
ALT-2,22.51315789
ALC-1,36.97777778
ALC-2,39.34457831
BHT-1,30.83109756
BHT-2,18.46388889
BHC-1,38.75744681
BHC-2,33.77777778
BLT-1,20.17241379
BLT-2,8.981132075
BLC-1,31.62972973
BLC-2,41.34036145
CHT-1,12.41714286
CHT-2,24.81203008
CHC-1,42.39375
CHC-2,62.94036145
CLT-1,48.96337209
CLT-2,37.02857143
CLC-1,33.95694444
CLC-2,36.97133758
```

Soil moisture and soil temperature

This data presents the 3 thermometer and 3 TDR observations at each subplot for each day of observation. This data is plotted in fig. 3B and 3C in the paper, it is not used by the scripts presented in this document.

Header description:

- *"date": Date of observation.*
- *"subplot": Code indicating the plot (A, B or C), topological position (Low or High), and crop type (RCG or FGL).*
- *"theta1", "theta2", "theta3": TDR readings indicating volumetric water content (un-calibrated) of the top 12cm of soil. The three readings were averaged for each subplot.*
- *"T1", "T2", "T3": Thermometer readings indicating soil temperature at 2.5cm depth. The three readings were averaged for each subplot.*
- *"ICE": Visual observations indicating the presence of ice at each subplot. Not presented in the paper.*

```
date,subplot,theta1,theta2,theta3,T1,T2,T3,ICE
3/27/2013,AHT,50,52,55,40.6,40.2,41.2,N
3/27/2013,AHC,51,47,43,31.1,31.4,31.3,Y
3/27/2013,ALT,68,64,68,31.8,34.2,31.6,Y
3/27/2013,ALC,66,63,65,31.5,31.5,31.3,Y
3/27/2013,BHT,47,43,48,39.9,40.2,38.2,N
3/27/2013,BHC,47,44,43,32,31.4,31.6,Y
3/27/2013,BLT,65,65,65,40.1,42,42.5,N
3/27/2013,BLC,61,52,66,31.2,31.6,31.3,Y
3/27/2013,CHT,45,44,48,41.2,38.8,42.4,N
3/27/2013,CHC,22,33,27,31.2,31,31.3,Y
3/27/2013,CLT,68,67,57,32,32.8,31.3,Y
3/27/2013,CLC,66,69,65,33.4,31.3,31.5,Y
3/28/2013,AHT,52,49,58,37.6,37.7,38.4,N
3/28/2013,AHC,62,43,39,31.1,31.6,31.6,Y
3/28/2013,ALT,64,67,63,33.9,35.5,35.7,N
3/28/2013,ALC,65,63,66,33.9,33.7,31.5,M
3/28/2013,BHT,45,43,51,37.6,37.2,37,N
3/28/2013,BHC,48,46,39,33.3,32.4,33,M
3/28/2013,BLT,68,65,65,37,38.3,39.2,N
3/28/2013,BLC,69,43,65,31.2,31.1,31.4,Y
3/28/2013,CHT,41,44,37,37.8,36.7,38.3,N
3/28/2013,CHC,43,40,28,31.2,33.1,31.3,Y
3/28/2013,CLT,78,72,67,32.4,32.3,31.7,Y
```

3/28/2013,CLC,75,70,68,34.5,32.5,32.3,N
3/29/2013,AHT,51,47,55,39.5,41,40.5,N
3/29/2013,AHC,58,48,37,30.9,32.1,32.5,Y
3/29/2013,ALT,65,65,63,36,38.4,40.1,N
3/29/2013,ALC,64,64,67,32.8,34.2,34.9,M
3/29/2013,BHT,44,43,50,39.7,39.9,39.5,N
3/29/2013,BHC,44,44,44,35.4,37.2,36.7,N
3/29/2013,BLT,66,61,66,42.3,42.7,43.1,N
3/29/2013,BLC,60,57,50,31.2,31.8,31.3,Y
3/29/2013,CHT,44,40,46,41.7,41.3,41.5,N
3/29/2013,CHC,31,33,34,31.2,32.1,30.9,Y
3/29/2013,CLT,67,70,74,34.1,34.5,31.4,M
3/29/2013,CLC,67,71,63,37.7,37.2,36.8,N
3/30/2013,AHT,45,43,56,41.6,50.4,46.1,N
3/30/2013,AHC,57,51,33,31.3,32.3,38.8,Y
3/30/2013,ALT,60,56,56,39.1,43.9,44.4,N
3/30/2013,ALC,56,61,64,35,39.3,37,N
3/30/2013,BHT,42,47,47,43.9,45.9,43.8,N
3/30/2013,BHC,40,45,42,37.1,41.3,37.9,N
3/30/2013,BLT,62,61,64,44.8,48.5,51.3,N
3/30/2013,BLC,58,47,62,31.3,31.6,31.5,Y
3/30/2013,CHT,35,44,47,46.8,44.1,48.7,N
3/30/2013,CHC,24,22,41,31.3,33.5,31.4,Y
3/30/2013,CLT,68,70,64,34.9,35.9,31.4,Y
3/30/2013,CLC,67,68,65,36.9,40.2,37.6,N
3/31/2013,AHT,48,50,51,40,40.4,40.4,N
3/31/2013,AHC,55,62,48,31.4,33.6,32.4,M
3/31/2013,ALT,64,62,65,38.3,39.1,39,N
3/31/2013,ALC,66,64,65,36,37,35.9,N
3/31/2013,BHT,44,43,50,39.9,39.1,39.6,N
3/31/2013,BHC,42,47,49,37.8,36.5,36.7,N
3/31/2013,BLT,61,65,63,40.4,41.1,41.5,N
3/31/2013,BLC,62,56,64,31.7,31.5,32.3,M
3/31/2013,CHT,46,54,48,41,39.7,40,N
3/31/2013,CHC,32,40,36,31.2,31.4,31.5,Y
3/31/2013,CLT,75,68,67,35.5,36.3,31.1,M
3/31/2013,CLC,70,69,59,36.3,37,36.9,N
4/1/2013,AHT,53,56,65,40.4,39.4,41.5,N
4/1/2013,AHC,61,67,52,35.5,32.4,36.7,M
4/1/2013,ALT,65,67,67,37.6,39.7,40.1,N
4/1/2013,ALC,73,69,69,36.5,37.7,37,N
4/1/2013,BHT,46,43,52,39.5,38.2,39,N
4/1/2013,BHC,50,56,43,37.8,35.5,36.9,N
4/1/2013,BLT,64,67,69,38.4,40.3,41.5,N
4/1/2013,BLC,64,69,66,36.5,35.4,34.7,M
4/1/2013,CHT,55,55,47,41,37.7,39.5,N
4/1/2013,CHC,43,48,53,31.6,32.4,31.5,M
4/1/2013,CLT,76,71,73,35.9,36.1,35.8,N
4/1/2013,CLC,75,71,69,38.1,36.5,37.6,N
4/2/2013,AHT,49,44,55,36.7,36.8,33.5,N
4/2/2013,AHC,62,59,52,32.3,32.9,32.3,N
4/2/2013,ALT,66,63,64,33.8,34.9,36.4,N
4/2/2013,ALC,63,62,65,32.3,35.3,33.1,N
4/2/2013,BHT,38,48,54,36.1,36.9,34.7,N
4/2/2013,BHC,46,45,46,33.7,34.8,33.5,N
4/2/2013,BLT,65,65,63,37,37.4,38.2,N
4/2/2013,BLC,62,55,67,32.8,31,32.9,M
4/2/2013,CHT,45,43,48,35.9,35.1,33.7,N
4/2/2013,CHC,37,41,44,31.2,30.9,31.2,Y
4/2/2013,CLT,78,70,74,32.2,32.1,31.8,N
4/2/2013,CLC,70,68,69,32.7,33.4,33.7,N
4/3/2013,AHT,46,48,52,32.5,34.9,33,M

4/3/2013,AHC,56,57,51,31.5,31.9,31.3,M
4/3/2013,ALT,64,60,57,31.8,34.2,31.6,M
4/3/2013,ALC,62,61,65,31.7,32.5,32.1,N
4/3/2013,BHT,41,41,49,35.5,33.8,31.6,M
4/3/2013,BHC,45,45,37,34,33.3,32.2,N
4/3/2013,BLT,64,60,63,36,34.9,33.4,N
4/3/2013,BLC,60,67,68,32,30.7,32.4,M
4/3/2013,CHT,43,44,43,33.6,36.5,34.1,N
4/3/2013,CHC,36,39,37,31.3,31.3,31.1,Y
4/3/2013,CLT,79,65,73,32,31.9,32.2,N
4/3/2013,CLC,70,68,61,31.9,37,33,N
4/4/2013,AHT,44,50,54,41.8,43.5,41.2,N
4/4/2013,AHC,58,44,44,31.2,34,31.6,M
4/4/2013,ALT,59,55,55,33.2,39.5,31.5,M
4/4/2013,ALC,60,58,66,32,33.8,33.7,M
4/4/2013,BHT,36,39,47,44.9,44.2,42.8,N
4/4/2013,BHC,43,44,40,37.4,41.7,32.2,N
4/4/2013,BLT,59,57,62,39.1,46.8,37.4,M
4/4/2013,BLC,54,53,64,32.8,40.8,34.1,M
4/4/2013,CHT,40,41,45,35.7,45.7,36.6,N
4/4/2013,CHC,32,39,38,31.1,34,31.6,Y
4/4/2013,CLT,73,66,68,31.4,33.2,33.5,M
4/4/2013,CLC,67,68,61,32.1,37.9,33.2,N
4/5/2013,AHT,43,41,49,43.4,46.4,45.3,N
4/5/2013,AHC,53,53,48,31.1,33.2,32.2,Y
4/5/2013,ALT,59,55,53,38.5,41.5,42,N
4/5/2013,ALC,58,60,64,36.1,39,36.1,N
4/5/2013,BHT,34,41,34,41.9,46.6,39.8,N
4/5/2013,BHC,38,36,42,37.7,42.9,42.9,N
4/5/2013,BLT,62,57,54,40.5,48.3,43.7,N
4/5/2013,BLC,60,65,62,38,39.2,37.5,N
4/5/2013,CHT,35,39,46,41.9,48.8,44.9,N
4/5/2013,CHC,37,38,40,31.2,37.1,31.4,M
4/5/2013,CLT,72,64,68,36.2,37.7,38.3,N
4/5/2013,CLC,66,67,60,37.7,37.7,36.6,N
4/6/2013,AHT,45,43,52,44,48.4,40.7,N
4/6/2013,AHC,53,55,44,31.2,40.8,33.8,Y
4/6/2013,ALT,59,56,59,38.9,44.8,42.2,N
4/6/2013,ALC,62,60,60,36.7,41.1,37.6,N
4/6/2013,BHT,41,43,44,42.4,47.1,40.1,N
4/6/2013,BHC,46,50,43,37.9,42.4,42.2,N
4/6/2013,BLT,58,56,51,40.9,51.2,42.9,N
4/6/2013,BLC,53,63,64,38.4,35.8,37.8,N
4/6/2013,CHT,38,50,44,41.2,53.7,47.8,N
4/6/2013,CHC,40,45,41,31.4,41.4,31.4,M
4/6/2013,CLT,73,69,66,37.4,38.4,37.7,N
4/6/2013,CLC,67,67,61,37.6,42.8,34.2,N
4/7/2013,AHT,45,43,51,46,54.5,47.6,N
4/7/2013,AHC,55,50,53,34.2,46.2,40.5,N
4/7/2013,ALT,55,56,57,42.9,46.6,44.6,N
4/7/2013,ALC,59,59,60,40.2,45.5,40.9,N
4/7/2013,BHT,33,33,44,45.7,52.4,46.9,N
4/7/2013,BHC,42,40,38,40.2,46.6,42.3,N
4/7/2013,BLT,54,56,58,42.6,50.7,45.5,N
4/7/2013,BLC,59,61,62,42.4,45.3,40.7,N
4/7/2013,CHT,38,37,43,44.8,48.4,48.7,N
4/7/2013,CHC,39,42,40,42.1,44.6,31.8,M
4/7/2013,CLT,72,61,66,40.8,42.7,42.1,N
4/7/2013,CLC,65,62,64,41.7,46.8,40.5,N

Meteorological data

This data was recorded by a micrometeorological station at the study site. It is not used by any of the scripts presented in this document. Presented here is hourly rainfall and air temperature, the data are plotted in fig. 3B and 3C in the paper.

Header description:

- *"timestamp": Date and hour of observation.*
- *"rain": Cumulative precipitation in mm recorded by the tipping-bucket rain gage over the previous hour ending at the time indicated by "timestamp".*
- *"airT": Average air temperature in degrees Celsius over the previous hour ending at the time indicated by "timestamp".*

```
timestamp,rain,airT
3/25/2013 0:00,0,-1.387633
3/25/2013 1:00,0,-1.158528
3/25/2013 2:00,0,-0.5833145
3/25/2013 3:00,0,-0.257293
3/25/2013 4:00,0,-0.371079
3/25/2013 5:00,0,-0.549853
3/25/2013 6:00,0,-1.194256
3/25/2013 7:00,0,-0.635639
3/25/2013 8:00,0,0.3455695
3/25/2013 9:00,0,1.1999815
3/25/2013 10:00,0,2.9827855
3/25/2013 11:00,0,3.998496
3/25/2013 12:00,0,4.5546295
3/25/2013 13:00,0,4.608985
3/25/2013 14:00,0,4.6692535
3/25/2013 15:00,0,4.6747685
3/25/2013 16:00,0,4.331479
3/25/2013 17:00,0,4.206591
3/25/2013 18:00,0,2.614166
3/25/2013 19:00,0,2.138891
3/25/2013 20:00,0,1.642219
3/25/2013 21:00,0,0.885412
3/25/2013 22:00,0,0.422847
3/25/2013 23:00,0,0.2873225
3/26/2013 0:00,0,0.1666625
3/26/2013 1:00,0,0.1085475
3/26/2013 2:00,0,0.09633
3/26/2013 3:00,0,0.032088
3/26/2013 4:00,0,-0.100591
3/26/2013 5:00,0,-0.3304035
3/26/2013 6:00,0,-0.8350685
3/26/2013 7:00,0,-0.3703965
3/26/2013 8:00,0,0.3836105
3/26/2013 9:00,0,1.9291475
```

3/26/2013 10:00,0,2.8841615
3/26/2013 11:00,0,2.964362
3/26/2013 12:00,0,3.235008
3/26/2013 13:00,0,4.2054885
3/26/2013 14:00,0,4.4907425
3/26/2013 15:00,0,5.190708
3/26/2013 16:00,0,5.482612
3/26/2013 17:00,0,4.8840085
3/26/2013 18:00,0,3.5377065
3/26/2013 19:00,0,1.9769695
3/26/2013 20:00,0,0.4328565
3/26/2013 21:00,0,-1.4387155
3/26/2013 22:00,0,-2.2543155
3/26/2013 23:00,0,-1.495587
3/27/2013 0:00,0,-0.6012975
3/27/2013 1:00,0,-1.4072635
3/27/2013 2:00,0,-1.814778
3/27/2013 3:00,0,-2.453538
3/27/2013 4:00,0,-2.4611655
3/27/2013 5:00,0,-1.0228425
3/27/2013 6:00,0,-0.267199
3/27/2013 7:00,0,0.2482235
3/27/2013 8:00,0,1.1887585
3/27/2013 9:00,0,2.3913935
3/27/2013 10:00,0,3.6060515
3/27/2013 11:00,0,5.0290075
3/27/2013 12:00,0,5.969126
3/27/2013 13:00,0,6.197451
3/27/2013 14:00,0,5.640847
3/27/2013 15:00,0,4.745425
3/27/2013 16:00,0,2.735622
3/27/2013 17:00,3.006,0.8653165
3/27/2013 18:00,0,1.365711
3/27/2013 19:00,0,1.5040545
3/27/2013 20:00,1.008,1.2533165
3/27/2013 21:00,1.008,0.833964
3/27/2013 22:00,0,0.4292035
3/27/2013 23:00,0,0.416136
3/28/2013 0:00,0,0.389147
3/28/2013 1:00,0,0.3640675
3/28/2013 2:00,0,0.260798
3/28/2013 3:00,0,0.070085
3/28/2013 4:00,0,-0.0429005
3/28/2013 5:00,0,-0.324157
3/28/2013 6:00,0,-0.3992145
3/28/2013 7:00,0,-0.2782015
3/28/2013 8:00,0,-0.090076
3/28/2013 9:00,0,0.152828
3/28/2013 10:00,6.012,0.63376
3/28/2013 11:00,3.996,1.0293
3/28/2013 12:00,0,2.5378985
3/28/2013 13:00,0,3.9978325
3/28/2013 14:00,0,4.2237655
3/28/2013 15:00,0,4.2738215
3/28/2013 16:00,1.008,4.488572
3/28/2013 17:00,0,4.336584
3/28/2013 18:00,0,3.8309655
3/28/2013 19:00,0,3.4911535
3/28/2013 20:00,0,3.2882435
3/28/2013 21:00,0,3.1233825
3/28/2013 22:00,0,2.832413
3/28/2013 23:00,0,2.604663

3/29/2013 0:00,0,2.407055
3/29/2013 1:00,0,2.1277475
3/29/2013 2:00,0,1.730929
3/29/2013 3:00,0,1.578081
3/29/2013 4:00,0,1.261974
3/29/2013 5:00,0,1.0059425
3/29/2013 6:00,0,0.849456
3/29/2013 7:00,0,1.276723
3/29/2013 8:00,0,2.162775
3/29/2013 9:00,0,2.3911145
3/29/2013 10:00,0,2.5646665
3/29/2013 11:00,0,3.982957
3/29/2013 12:00,0,4.3911515
3/29/2013 13:00,0,4.9012075
3/29/2013 14:00,0,6.299836
3/29/2013 15:00,0,6.4810065
3/29/2013 16:00,0,5.6796175
3/29/2013 17:00,0,5.593612
3/29/2013 18:00,0,5.1621825
3/29/2013 19:00,0,3.985669
3/29/2013 20:00,0,1.775075
3/29/2013 21:00,0,0.389531
3/29/2013 22:00,0,0.456173
3/29/2013 23:00,0,-0.23323
3/30/2013 0:00,0,-1.7447845
3/30/2013 1:00,0,-2.5216535
3/30/2013 2:00,0,-3.1200505
3/30/2013 3:00,0,-3.7166605
3/30/2013 4:00,0,-4.2867325
3/30/2013 5:00,0,-4.8145095
3/30/2013 6:00,0,-5.076588
3/30/2013 7:00,0,-2.862538
3/30/2013 8:00,0,1.5622255
3/30/2013 9:00,0,3.565907
3/30/2013 10:00,0,5.0392395
3/30/2013 11:00,0,6.667518
3/30/2013 12:00,0,7.7132305
3/30/2013 13:00,0,8.5000655
3/30/2013 14:00,0,9.288278
3/30/2013 15:00,0,9.470215
3/30/2013 16:00,0,9.605809
3/30/2013 17:00,0,9.4813165
3/30/2013 18:00,0,8.633081
3/30/2013 19:00,0,5.6202455
3/30/2013 20:00,0,2.545075
3/30/2013 21:00,0,0.679475
3/30/2013 22:00,0,-0.0796505
3/30/2013 23:00,0,-1.0172
3/31/2013 0:00,0,-1.603476
3/31/2013 1:00,0,-1.9675045
3/31/2013 2:00,0,-2.365454
3/31/2013 3:00,0,-0.5059715
3/31/2013 4:00,0,3.0730875
3/31/2013 5:00,0,3.261359
3/31/2013 6:00,0,3.5405645
3/31/2013 7:00,0,4.9357565
3/31/2013 8:00,0,5.879951
3/31/2013 9:00,0,7.2019145
3/31/2013 10:00,0,8.803653
3/31/2013 11:00,0,10.274641
3/31/2013 12:00,0,10.476785
3/31/2013 13:00,0,7.9532345

3/31/2013 14:00,4.014,6.438175
3/31/2013 15:00,3.996,5.9957725
3/31/2013 16:00,2.016,6.0519815
3/31/2013 17:00,3.006,5.92266
3/31/2013 18:00,3.996,5.794207
3/31/2013 19:00,3.996,5.771237
3/31/2013 20:00,3.996,5.9356075
3/31/2013 21:00,3.006,5.970942
3/31/2013 22:00,0,5.942064
3/31/2013 23:00,0,5.8201975
4/1/2013 0:00,0,5.439584
4/1/2013 1:00,0,4.9921995
4/1/2013 2:00,0,4.7143205
4/1/2013 3:00,0,4.710811
4/1/2013 4:00,0,5.565026
4/1/2013 5:00,0,5.703985
4/1/2013 6:00,14.004,5.3207385
4/1/2013 7:00,0,5.2895015
4/1/2013 8:00,0,5.0900765
4/1/2013 9:00,0,3.749154
4/1/2013 10:00,0,0.2292935
4/1/2013 11:00,0,1.254603
4/1/2013 12:00,1.008,2.562459
4/1/2013 13:00,0,3.498046
4/1/2013 14:00,0,2.697836
4/1/2013 15:00,0,1.8319805
4/1/2013 16:00,0,1.733764
4/1/2013 17:00,0,1.2854705
4/1/2013 18:00,0,-0.5168905
4/1/2013 19:00,0,-1.525236
4/1/2013 20:00,0,-1.8557935
4/1/2013 21:00,0,-2.846816
4/1/2013 22:00,0,-3.689909
4/1/2013 23:00,0,-3.773149
4/2/2013 0:00,0,-3.6259235
4/2/2013 1:00,0,-3.821981
4/2/2013 2:00,0,-4.201957
4/2/2013 3:00,0,-4.568811
4/2/2013 4:00,0,-4.8229465
4/2/2013 5:00,0,-5.2921455
4/2/2013 6:00,0,-5.6044385
4/2/2013 7:00,0,-4.763849
4/2/2013 8:00,0,-3.937325
4/2/2013 9:00,0,-3.11132
4/2/2013 10:00,0,-2.5670795
4/2/2013 11:00,0,-2.117048
4/2/2013 12:00,0,-1.303113
4/2/2013 13:00,0,-0.8364345
4/2/2013 14:00,0,-0.3845625
4/2/2013 15:00,0,-0.019739
4/2/2013 16:00,0,0.077931
4/2/2013 17:00,0,-0.1801
4/2/2013 18:00,0,-0.535928
4/2/2013 19:00,0,-0.951189
4/2/2013 20:00,0,-1.447989
4/2/2013 21:00,0,-1.731664
4/2/2013 22:00,0,-2.3637845
4/2/2013 23:00,0,-2.8433795
4/3/2013 0:00,0,-2.9561205
4/3/2013 1:00,0,-2.7025245
4/3/2013 2:00,0,-2.979087
4/3/2013 3:00,0,-3.116619

4/3/2013 4:00,0,-3.35897
4/3/2013 5:00,0,-3.720631
4/3/2013 6:00,0,-3.906951
4/3/2013 7:00,0,-3.605711
4/3/2013 8:00,0,-3.0220605
4/3/2013 9:00,0,-2.3537055
4/3/2013 10:00,0,-1.8476065
4/3/2013 11:00,0,-1.1808975
4/3/2013 12:00,0,-0.945571
4/3/2013 13:00,0,0.0475925
4/3/2013 14:00,0,-0.483062
4/3/2013 15:00,0,-0.244451
4/3/2013 16:00,0,-0.2107495
4/3/2013 17:00,0,0.342697
4/3/2013 18:00,0,-0.1110505
4/3/2013 19:00,0,-0.7424425
4/3/2013 20:00,0,-1.257459
4/3/2013 21:00,0,-1.739089
4/3/2013 22:00,0,-1.8599395
4/3/2013 23:00,0,-2.3404615
4/4/2013 0:00,0,-3.116063
4/4/2013 1:00,0,-4.4919195
4/4/2013 2:00,0,-5.612397
4/4/2013 3:00,0,-6.039366
4/4/2013 4:00,0,-6.6096665
4/4/2013 5:00,0,-6.884726
4/4/2013 6:00,0,-6.9821335
4/4/2013 7:00,0,-4.2251705
4/4/2013 8:00,0,-1.988401
4/4/2013 9:00,0,-0.0536945
4/4/2013 10:00,0,2.177504
4/4/2013 11:00,0,4.506314
4/4/2013 12:00,0,6.4656485
4/4/2013 13:00,0,8.396984
4/4/2013 14:00,0,9.6055855
4/4/2013 15:00,0,10.4940115
4/4/2013 16:00,0,10.956469
4/4/2013 17:00,0,11.1016495
4/4/2013 18:00,0,9.8198835
4/4/2013 19:00,0,8.1983655
4/4/2013 20:00,0,6.8502365
4/4/2013 21:00,0,6.04047
4/4/2013 22:00,0,5.4198675
4/4/2013 23:00,0,4.6952625
4/5/2013 0:00,0,3.9934925
4/5/2013 1:00,0,3.722647
4/5/2013 2:00,0,3.339049
4/5/2013 3:00,0,3.0008825
4/5/2013 4:00,0,2.6693065
4/5/2013 5:00,0,-0.3339865
4/5/2013 6:00,0,-1.6901175
4/5/2013 7:00,0,0.6682655
4/5/2013 8:00,0,2.7733685
4/5/2013 9:00,0,4.006155
4/5/2013 10:00,0,5.595822
4/5/2013 11:00,0,6.1913875
4/5/2013 12:00,0,6.7456645
4/5/2013 13:00,0,7.0406965
4/5/2013 14:00,0,6.902244
4/5/2013 15:00,0,5.573597
4/5/2013 16:00,0,4.708789
4/5/2013 17:00,0,3.6872935

4/5/2013 18:00,0,2.965753
4/5/2013 19:00,0,1.9138485
4/5/2013 20:00,0,0.9617785
4/5/2013 21:00,0,-0.03902
4/5/2013 22:00,0,-0.478046
4/5/2013 23:00,0,-1.331876
4/6/2013 0:00,0,-1.9154575
4/6/2013 1:00,0,-2.259844
4/6/2013 2:00,0,-2.743064
4/6/2013 3:00,0,-3.274259
4/6/2013 4:00,0,-3.483005
4/6/2013 5:00,0,-4.0962725
4/6/2013 6:00,0,-5.3682455
4/6/2013 7:00,0,-3.206344
4/6/2013 8:00,0,-1.391079
4/6/2013 9:00,0,-0.335084
4/6/2013 10:00,0,0.839329
4/6/2013 11:00,0,1.9229425
4/6/2013 12:00,0,2.9313165
4/6/2013 13:00,0,3.822001
4/6/2013 14:00,0,4.9814045
4/6/2013 15:00,0,6.572503
4/6/2013 16:00,0,7.790002
4/6/2013 17:00,0,8.5475225
4/6/2013 18:00,0,7.688661
4/6/2013 19:00,0,6.5725245
4/6/2013 20:00,0,5.9144165
4/6/2013 21:00,0,5.946435
4/6/2013 22:00,0,6.295218
4/6/2013 23:00,0,6.8310705
4/7/2013 0:00,0,6.763797
4/7/2013 1:00,0,6.479946
4/7/2013 2:00,0,6.510149
4/7/2013 3:00,0,6.6808315
4/7/2013 4:00,0,6.7017915
4/7/2013 5:00,0,6.783061
4/7/2013 6:00,0,6.9230105
4/7/2013 7:00,0,7.073439
4/7/2013 8:00,0,7.2041305
4/7/2013 9:00,0,7.821482
4/7/2013 10:00,0,9.29973
4/7/2013 11:00,0,11.4102545
4/7/2013 12:00,0,14.3761965
4/7/2013 13:00,0,15.6359475
4/7/2013 14:00,0,16.3163155
4/7/2013 15:00,0,17.2246335
4/7/2013 16:00,0,17.575189
4/7/2013 17:00,0,17.5421025
4/7/2013 18:00,0,17.0223435
4/7/2013 19:00,0,15.9008485
4/7/2013 20:00,0,14.714512
4/7/2013 21:00,0,11.1190725
4/7/2013 22:00,0,8.1942365
4/7/2013 23:00,0,6.3445385
4/8/2013 0:00,0,5.121964

R code for processing data and performing statistical analysis of fluxes

Script 1:

This code is run on the raw gas chromatograph data after peak integration. It cleans up the raw data, makes calibration curves, and calculates concentrations of N_2O for each field sample, then writes a csv file containing the concentration data.

```
################################################
#clear all variables
rm(list=ls())


#set working directory to source of csv files
setwd("./final_data/csvfiles")


#loads tables from csv files as variable called "RSTUYZN2O"
RSTUYZN2O<-read.csv("FT529.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill =
TRUE, comment.char="")
#discards data marked with "REJY" in extra_field
RSTUYZN2O<-RSTUYZN2O[RSTUYZN2O$extra_field != "REJY",]
#reforms dataframes without null entries
RSTUYZN2O<-RSTUYZN2O[RSTUYZN2O$samplename != "no data",]
#drop samples with zero peak area
RSTUYZN2O<-RSTUYZN2O[RSTUYZN2O$ECDarea1 != 0,]
#add new column for concentration
RSTUYZN2O$conc_ppm<-NA
#convert dates from factors to dates
```

```
RSTUYZN2O$collectdate<-
as.Date(as.character(RSTUYZN2O$collectdate),format="%Y%m%d")
#convert samplename to characterstring
RSTUYZN2O$samplename<-as.character(RSTUYZN2O$samplename)
#converts sample comment field from factors to character arrays, then substring of first 3
characters
RSTUYZN2O$samplecomment<-substr(as.character(RSTUYZN2O$samplecomment),1,3)
###############################################################################
######
#separates data by Check samples, calibrations and field samples based on "CAL" or "CHK" in
the sample comment
#split data into separate dataframes based on "CAL" and "CHK"
RSTUYZN2O_CAL<-RSTUYZN2O[RSTUYZN2O$samplecomment == "CAL",]
#add extra field for quadratic calibration curves
RSTUYZN2O_CAL$areaSQ <- (RSTUYZN2O_CAL$ECDarea1)^2
#remaining data should be all field samples
RSTUYZN2O_FLD<-RSTUYZN2O[RSTUYZN2O$samplecomment != "CHK" &
RSTUYZN2O$samplecomment !="CAL",]
###############################################################################
########
#set up calibration table:
#establish concentrations for standards
#assigns values to concentration field based on calibration name
```

```
#assign injections concentration for standard mix
RSTUYZN2O_CAL$conc_ppm[RSTUYZN2O_CAL$samplename == "0.33"]<- 0.33
#assign value for 50/50
RSTUYZN2O_CAL$conc_ppm[RSTUYZN2O_CAL$samplename == "0.5"]<- 0.5
#assign value for N2O standard
RSTUYZN2O_CAL$conc_ppm[RSTUYZN2O_CAL$samplename == "0.8"]<- 0.8
################################################################################
#########
#do regression models for each set of calibrations
#splits 1x CALS into dataframes by collection date
CAL<-split(RSTUYZN2O_CAL, RSTUYZN2O_CAL$originalsequence, drop=TRUE)
#same to keep points
PTS<-split(RSTUYZN2O_CAL, RSTUYZN2O_CAL$originalsequence, drop=TRUE)
  #loop replaces data frame elements of CAL1X with a regression model of that dataframe
  for (j in 1:length(CAL))
  {
    CAL[[j]]<-lm(conc_ppm ~ ECDarea1, CAL[[j]], na.action = na.omit)
  }
################################################################################
#######
#plots all regression models
xpt <- seq(from = 0, to = 130, by = 0.1)
```

```
for (i in 1:length(CAL))
{
  windows()
  #plots calibration points
  plot(PTS[[i]]$ECDarea1, PTS[[i]]$conc_ppm, type='p',pch=19, cex = 1,col=1,
main=names(CAL[i]),xlab="Peak area", ylab="Concentration (ppm)", ylim = c(0,1),
xlim=c(0,130))
  par(new=TRUE)

  #plots regression line
  abline(reg=CAL[[i]], untf = FALSE, col="red")
}

#combine all regression models into one data frame
CAL.lm<-CAL
##################################################################################
##########
#establish concentrations for all field samples based on appropriate linear model coefficients
#math convert to injection concentration from vial concentration

RSTUYZN2O_FLD$CALslope<-NA
RSTUYZN2O_FLD$CALintercept<-NA
```

```
for (k in 1:length(RSTUYZN2O_FLD$samplename))
  {


  #intercept
  RSTUYZN2O_FLD$CALintercept[k]<-
coef(eval(parse(text=paste("CAL.lm$'",RSTUYZN2O_FLD$originalsequence[k],"'",sep=""))))[
1]

  #slope (ECDarea2)
  RSTUYZN2O_FLD$CALslope[k]<-
coef(eval(parse(text=paste("CAL.lm$'",RSTUYZN2O_FLD$originalsequence[k],"'",sep=""))))[
2]

  # squared coefficient
  RSTUYZN2O_FLD$conc_ppm[k]<-
((RSTUYZN2O_FLD$CALslope[k]*RSTUYZN2O_FLD$ECDarea1[k]) +
RSTUYZN2O_FLD$CALintercept[k])

}

####################################################################################
################################################
```

```
#print concentration data to output file

setwd("..")

setwd("..")

setwd("./concentration")

write.csv(RSTUYZN2O_FLD, file = "FT_conc.CSV")
```

Script 2:

This script loads the output of script 1. It organizes the concentration data by chamber and determines the slope dC/dt by linear regression. It plots the regression along with the original data points for visual verification, then assembles a dataframe of final slope values for each chamber and writes this to a csv file.

```
#clear all variables
rm(list=ls())
#set working directory to source of csv files
setwd("./concentration")
#loads tables from csv files
conc<-read.csv("FT_conc.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill = TRUE,
comment.char="")
#add column to dataframe and add concatenated info for each replicate
conc$repID<-paste(conc$collectdate, conc$subplot, conc$position, conc$treatment,
conc$replicate, sep="/")
#add column for (correcttime)^2 for regression fiting later
conc$tsquare<-(conc$correcttime^2)
#creates nested dataframes for each replicate
conc.df<-split(conc, conc$repID)
#creates more dataframes to receive modles and "n" based on same dimensions as conc.df
quad.df<-split(conc, conc$repID)
linear.df<-split(conc, conc$repID)
```

```
n.df<-split(conc, conc$repID)


#loop to determine dc/dt at t = 0 for each replicate time series
for (i in 1:length(conc.df))
{
  #write number of points to n.df
  eval(parse(text=paste("n.df$'", names(conc.df[i]),"'<-length(rownames(conc.df[[i]]))", sep="")))
  # if there are 3 points, do a linear regression and send the model to linear.df data frame
  if (length(rownames(conc.df[[i]])) == 3)
  {
    eval(parse(text=paste("quad.df$'", names(conc.df[i]),"'<-NA", sep="")))
    eval(parse(text=paste("linear.df$'", names(conc.df[i]),"'<-lm(conc_ppm ~ correcttime,
conc.df[[i]])", sep="")))
  }
  #if there are four points, calcualate both linear and quadratic models and send to dataframes
  else
  {
    eval(parse(text=paste("quad.df$'", names(conc.df[i]),"'<-lm(conc_ppm ~ correcttime +
tsquare, conc.df[[i]])", sep="")))
    eval(parse(text=paste("linear.df$'", names(conc.df[i]),"'<-lm(conc_ppm ~ correcttime,
conc.df[[i]])", sep="")))
  }
  #entry for replicates with less than 3 points, no model but print replicate and "n"
```

```
  if (length(rownames(conc.df[[i]])) < 3)
  {
    eval(parse(text=paste("quad.df$'", names(conc.df[i]),"'<-NA", sep="")))
    eval(parse(text=paste("linear.df$'", names(conc.df[i]),"'<-NA", sep="")))
  }
}
####################################################################################
################
#plots of quadratic models and points

#create vector of x points
xpt<-seq(0,60, by=0.1)
for (k in 0:(floor(length(conc.df)/9)))
{
#mac wont recognize windows()function
  quartz()
  #windows()
par(mfrow=c(3,3))
  for (j in 1:9)
  {
    if ((9*k)+j > length(conc.df))
    {
      break
```

```
}
if (is.na(quad.df[(9*k)+j]) == TRUE & is.na(linear.df[(9*k)+j]) == TRUE)
 {
  next
 }
 else
 {
  if (is.na(quad.df[(9*k)+j]) == FALSE)
   {
    #creates y points to based on xpt and quadratic coefficients
    eval(parse(text = paste("ypt<-(coef(quad.df$'",names(conc.df[(9*k)+j]),"')[1] +
coef(quad.df$'",names(conc.df[(9*k)+j]),"')[2]*xpt +
coef(quad.df$'",names(conc.df[(9*k)+j]),"')[3]*xpt^2)", sep="")))
    #plots concentration vs. time for each replicate
    eval(parse(text=paste("plot(conc.df$'", names(conc.df[(9*k)+j]), "'$correcttime,",
"conc.df$'", names(conc.df[(9*k)+j]), "'$conc_ppm, type='p',pch=19, cex=2,col=2,
ylim=c(0.25,0.55))", sep="")))
    #plots quadratic regression points
    points(xpt, ypt)
   }
  else
   {
    #creates y points to based on xpt and linear coefficients
```

```
      eval(parse(text = paste("ypt<-(coef(linear.df$'",names(conc.df[(9*k)+j]),"')[1] +
coef(linear.df$'",names(conc.df[(9*k)+j]),"')[2]*xpt)", sep="")))
      #plots concentration vs. time for each replicate
      eval(parse(text=paste("plot(conc.df$'", names(conc.df[(9*k)+j]), "'$correcttime,",
"conc.df$'", names(conc.df[(9*k)+j]), "'$conc_ppm, type='p',pch=19, cex=2,col=3,
ylim=c(0.25,0.55))", sep="")))
      #plots quadratic regression points
      points(xpt, ypt)
    }
   }
 }
}
####################################################################################
##########################################
#create dataframe with final flux values for both linear and quadratics
flux.df<-as.data.frame(matrix(ncol=9,nrow=length(n.df)))
names(flux.df)<-c("date","subplot", "position",
"treatment","replicate","slopeL","LRsq","slopeQ","QRsq")

for (q in 1:length(n.df))
{
 flux.df$date[q]<-substr(names(n.df[q]), 1, 10)
 flux.df$subplot[q]<-substr(names(n.df[q]), 12, 12)
```

```
  flux.df$position[q]<-substr(names(n.df[q]), 14, 14)

  flux.df$treatment[q]<-substr(names(n.df[q]), 16, 16)

  flux.df$replicate[q]<-substr(names(n.df[q]), 18, 18)


  if (n.df[q] == 3)

  {

    eval(parse(text = paste("flux.df$slopeL[q]<-coef(linear.df$'", names(n.df[q]), "')[2]", sep=""
)))

    eval(parse(text = paste("flux.df$LRsq[q]<-summary(linear.df$'", names(n.df[q]),
"')$r.squared", sep="")))

    flux.df$slopeQ[q]<-NA

    flux.df$QRsq[q]<-NA

  }


  if (n.df[q] == 4)

  {

    eval(parse(text = paste("flux.df$slopeL[q]<-coef(linear.df$'", names(n.df[q]), "')[2]", sep=""
)))

    eval(parse(text = paste("flux.df$LRsq[q]<-summary(linear.df$'", names(n.df[q]),
"')$r.squared", sep="")))

    eval(parse(text = paste("flux.df$slopeQ[q]<-coef(quad.df$'", names(n.df[q]), "')[2]", sep=""
)))
```

```
   eval(parse(text = paste("flux.df$QRsq[q]<-summary(quad.df$'", names(n.df[q]),
"')$r.squared", sep="")))
  }
}
###################################################################################
###
#remove fluxes for replicates with n < 3
flux.df<-flux.df[is.na(flux.df$slopeL) == FALSE,]
#make dataframe from flux.df, replacing linear slope and Rsquared where quadratic is NA or
negative
slopeQ.df<-flux.df
#where slopeQ is NA (less than 4 points) replace QRsq with LRsq
slopeQ.df$QRsq[is.na(slopeQ.df$slopeQ) == TRUE]<-slopeQ.df$LRsq[is.na(slopeQ.df$slopeQ)
== TRUE]
#where slopeQ is NA, (less than 4 points), replace with slope L for that row
slopeQ.df$slopeQ[is.na(slopeQ.df$slopeQ) == TRUE]<-
slopeQ.df$slopeL[is.na(slopeQ.df$slopeQ) == TRUE]
#where quadratic slope is negative, replace  quadratic Rsquared with linear R squared
slopeQ.df$QRsq[slopeQ.df$slopeQ < 0]<-slopeQ.df$LRsq[slopeQ.df$slopeQ < 0]
#where quadratic slope is negative, replace quadratic slope with linear slope
slopeQ.df$slopeQ[slopeQ.df$slopeQ < 0]<-slopeQ.df$slopeL[slopeQ.df$slopeQ < 0]

#write slope datafiles
```

```
setwd("..")

setwd("./slope")

write.csv(slopeQ.df, file = "FT_slope.CSV")
```

Script 3:

This script loads the output of script 2. For flux calculation, it also loads the molar volume data which is based on the temperature and air pressure conditions for each date. Constants for chamber volume and area, as well as molar mass of N_2O are defined and the script calculates fluxes in units of g N_2O m^{-2} min^{-1} and writes an output file.

```
#clear all variables
rm(list=ls())
#Load data files
#set working directory to source of csv files
setwd("./slope")
#loads slope tables from csv files
slope.df<-read.csv("FT_slope.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill = TRUE,
comment.char="")
#set working directory to source of csv files
setwd("..")
setwd("./soilmoisture")
#loads Vm table from csv files
Vm.df<-read.csv("FT_Vm.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill = TRUE,
comment.char="")
########################################################################################
###########################################
#combine all data into one data frame!
```

```
#convert all dates to common format

Vm.df$date<-as.Date(Vm.df$date, format = '%m/%d/%Y')

slope.df$date<-as.Date(slope.df$date, format = '%Y-%m-%d')

#add columns to slope table and specify  enviornmental data

slope.df$Vm<-NA

#loop to add Vm to slope table by matching dates

for (i in 1:length(Vm.df$date))

{

slope.df$Vm[slope.df$date == Vm.df$date[i]]<-Vm.df$Vm_m3_mol[i]

}

####################################################################################

####################################################

#Establish other variables and calculate fluxes

#chamber volume in m3

Vcham<-0.019718

#chamber area in m2

Acham<-0.065563

#molecular mass N2O in g/mol

Mn2o<-44.0128


#create and populate flux column for both linear and quadratic regressions

flux.df<-slope.df

#fluxes ar in g m^-2 min-1
```

```
flux.df$fluxL<-flux.df$slopeL*(Vcham*Mn2o)/(Acham*flux.df$Vm*10^6)

flux.df$fluxQ<-flux.df$slopeQ*(Vcham*Mn2o)/(Acham*flux.df$Vm*10^6)

#add ID for unique chamber replicate

flux.df$ID<-as.factor(paste(flux.df$subplot, flux.df$position, flux.df$treatment,
flux.df$replicate, sep = ""))

#write fluxes to datafile

#set directory

setwd("..")

setwd("./flux")

#write file

write.csv(flux.df, file = "FT_flux_613.CSV")
```

Script 4:

This script loads the flux output file generated by script 3. It runs the Wilcoxon signed-rank test and the Kruskal-Wallis rank-sum test on all fluxes to determine differences between treatments.

```
#clear all variables
rm(list=ls())
#Load data files
#set working directory to source of csv files
setwd("./flux")
#loads slope tables from csv files
flux.df<-read.csv("FT_flux_613.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill =
TRUE, comment.char="")
# create ID 2 for treatments and position
flux.df$ID2 <-paste(flux.df$position, flux.df$treatment, sep = "")
##########################################################################################
####################################
#4. Wilcoxon signed-rank test for all daily pairs of subplots (i.e. AHT
# vs. AHC and AHT vs. ALT).
# average both replicates for each day
#split into pairs of reps
flux4.df <- split(flux.df, paste( substr(flux.df$ID,1,3),flux.df$date, sep = "."))
#create empty dataframe and name columns
```

```
mean4.df <- as.data.frame(matrix(data = NA, nrow = length(flux4.df), ncol = 7))
colnames(mean4.df) <- c( 'date', 'ID','ID2','strip','pos', 'treat', 'mean_flxL')
#loop to fill dataframe
for (i in 1:length(flux4.df))
{
  mean4.df$date[i] <- substr(names(flux4.df[i]),5,14 )
  mean4.df$ID[i] <- substr(names(flux4.df[i]),1,3 )
  mean4.df$ID2[i] <- substr(names(flux4.df[i]), 2,3)
  mean4.df$mean_flxL[i] <- mean(flux4.df[[i]]$fluxL, na.rm = FALSE)#False results in the
actual average for BLT on 4/4, NA. TRue results in the one remaining value
  mean4.df$strip[i] <-substr(mean4.df$ID[i],1,1)
  mean4.df$pos[i] <-substr(mean4.df$ID[i],2,2)
  mean4.df$treat[i] <-substr(mean4.df$ID[i],3,3)
}
######test 1
#test flux ~ treatment: not signifcant
#V = 994, p-value = 0.07298
wilcox.test(mean4.df$mean_flxL ~ mean4.df$treat, paired = TRUE, na.action = "na.pass")
#or
mean4.1.df <- split(mean4.df, mean4.df$treat)
#finds location of NA in "TREAT" split
NAvect1 <- is.na(mean4.1.df[[2]]$mean_flxL)
#set other pair to NA
```

```
is.na(mean4.1.df[[1]]$mean_flxL) <- NAvect1

wilcox.test(mean4.1.df[[1]]$mean_flxL, mean4.1.df[[2]]$mean_flxL, paired = TRUE)

#p-value = 0.1043 after OL removal

#######test 2

#test flux~position: not signifcant

#V = 1064, p-value = 0.1615, p-value = 0.2212 after outlier removal

wilcox.test(mean4.df$mean_flxL ~ mean4.df$pos, paired = TRUE, na.action = "na.pass")

#or

mean4.2.df <- split(mean4.df, mean4.df$pos)

#finds location of NA in "LOW" split

NAvect2 <- is.na(mean4.2.df[[2]]$mean_flxL)

#set other pair to NA

is.na(mean4.2.df[[1]]$mean_flxL) <- NAvect2

wilcox.test(mean4.2.df[[1]]$mean_flxL, mean4.2.df[[2]]$mean_flxL, paired = TRUE)

# p-value = 0.2212 after removing outlier


# WILCOX signed rank test : paired combos~~~~~~~~~~~~~~~~~~~~~~~~

mean4.3.df <- split(mean4.df, mean4.df$ID2)

### HC vs HT

#p-value = 0.1152

wilcox.test(mean4.3.df$HC$mean_flxL, mean4.3.df$HT$mean_flxL, paired = TRUE)

### HC vs. LT : significant!

#p-value = 0.02954, V = 195, p-value = 0.04946 after removing outlier
```

```
NAvect3 <- is.na(mean4.3.df[[4]]$mean_flxL)

is.na(mean4.3.df[[1]]$mean_flxL) <- NAvect3

wilcox.test(mean4.3.df$HC$mean_flxL, mean4.3.df$LT$mean_flxL, paired = TRUE)

#### HC vs. LC p-value = 0.09458

wilcox.test(mean4.3.df$HC$mean_flxL, mean4.3.df$LC$mean_flxL, paired = TRUE)


# HT vs LC p-value = 0.9074

wilcox.test(mean4.3.df$HT$mean_flxL, mean4.3.df$LC$mean_flxL, paired = TRUE)

# HT vs LT : significant!

#p-value = 0.000444,  p-value = 0.0008382 after removing outlier

NAvect4 <- is.na(mean4.3.df[[4]]$mean_flxL)

is.na(mean4.3.df[[2]]$mean_flxL) <- NAvect4

wilcox.test(mean4.3.df$HT$mean_flxL, mean4.3.df$LT$mean_flxL, paired = TRUE)


# LC vs LT: significant!

#p-value = 8.472e-05,  p-value = 0.0001637 after removing outlier

NAvect5 <- is.na(mean4.3.df[[4]]$mean_flxL)

is.na(mean4.3.df[[3]]$mean_flxL) <- NAvect5

wilcox.test(mean4.3.df$LC$mean_flxL, mean4.3.df$LT$mean_flxL, paired = TRUE)

###############################################################################

################################

#Kruskal-Wallis rank-sum test.
```

```
fluxL.v <- as.vector(flux.df$fluxL)

ID2.v <- as.factor(flux.df$ID2)

kruskal.test(fluxL.v, ID2.v)

#Kruskal-Wallis chi-squared = 19.8283, df = 3, p-value = 0.0001842

#chi-squared = 18.7511, df = 3, p-value = 0.0003078 after removing OL


#############################################

## Default S3 method:

flux5.df <-split(flux.df, flux.df$ID2)

HC.v <- as.vector(flux5.df$HC$fluxL)

HT.v <- as.vector(flux5.df$HT$fluxL)

LC.v <- as.vector(flux5.df$LC$fluxL)

LT.v <- as.vector(flux5.df$LT$fluxL)

#all four categories

kruskal.test( list(HC.v, HT.v, LC.v, LT.v))

#Kruskal-Wallis chi-squared = 19.8283, df = 3, p-value = 0.0001842

#chi-squared = 18.7511, df = 3, p-value = 0.0003078 after removing OL


# HC against rest

kruskal.test( list(HC.v, c(HT.v,LC.v,LT.v)))

# Kruskal-Wallis chi-squared = 0.4401, df = 1, p-value = 0.5071

#p-value = 0.4684 after removing OL
```

```
# HT against rest

kruskal.test( list(HT.v, c(HC.v,LC.v,LT.v)))

#Kruskal-Wallis chi-squared = 5.0185, df = 1, p-value = 0.02508

#p-value = 0.02851 after removing OL


# LC against rest

kruskal.test( list(LC.v, c(HT.v,HC.v,LT.v)))

#Kruskal-Wallis chi-squared = 5.5363, df = 1, p-value = 0.01863

#p-value = 0.02125 after removing OL


# LT against rest

kruskal.test( list(LT.v, c(HT.v,HC.v,LC.v)))

#Kruskal-Wallis chi-squared = 15.4428, df = 1, p-value = 8.504e-05

#p-value = 0.000153 after removing outlier


#paired combos~~~~~~~~~~~~~~~~~~~~~~

# HC vs HT p-value = 0.06907

kruskal.test( list(HC.v, HT.v))

# HC vs. LT p-value = 0.03665, p-value = 0.04927 after removing outlier

kruskal.test( list(HC.v, LT.v))

# HC vs. LC p-value = 0.05824

kruskal.test( list(HC.v, LC.v))
```

HT vs LC p-value = 0.9586

kruskal.test(list(HT.v, LC.v))

HT vs LT p-value = 0.0002058, p-value = 0.0003116 after removing outlier

kruskal.test(list(HT.v, LT.v))

LC vs LT p-value = 0.0001402, p-value = 0.0002136 after removing outlier

kruskal.test(list(LC.v, LT.v))

###################################

kruskal.test(flux.df$fluxL ~ as.factor(flux.df$ID2), flux.df)

#Kruskal-Wallis chi-squared = 19.8283, df = 3, p-value = 0.0001842, p-value = 0.0003078 after removing outlier

kruskal.test(flux.df$fluxL ~ as.factor(flux.df$treatment), flux.df)

#Kruskal-Wallis chi-squared = 2.1409, df = 1, p-value = 0.1434, p-value = 0.1712 after removing outlier

kruskal.test(flux.df$fluxL ~ as.factor(flux.df$pos), flux.df)

#Kruskal-Wallis chi-squared = 1.8647, df = 1, p-value = 0.1721, p-value = 0.204 after removing outlier

kruskal.test(flux.df$fluxL ~ as.factor(flux.df$date), flux.df)

#Kruskal-Wallis chi-squared = 11.3444, df = 11, p-value = 0.4149, p-value = 0.4306 after removing outlier

Script 5:

Like script 4, this script loads the flux output file generated by script 3. It first removes the hot-moment outlier, then explores the structure of the data before generating a linear model. It runs an ANOVA and an LSD test on the model.

```
#clear all variables
rm(list=ls())
# Getting the required packages, nlme to fit models with REML, others for skewness, and to run
MYSQL
library(nlme)
library(moments)
library(agricolae)
#Load data files
#set working directory to source of csv files
setwd("./flux")
#loads slope tables from csv files
flux.df<-read.csv("FT_flux_613.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill =
TRUE, comment.char="")
#rename flux.df columns
names(flux.df)[names(flux.df) == 'subplot'] <- 'plot'
names(flux.df)[names(flux.df) == 'treatment'] <- 'cover'
# create ID 2 for treatments and position
flux.df$ID2 <-as.factor(paste(flux.df$position, flux.df$cover, sep = ""))
```

```
#delete outlier: BLT2 on 4/4

flux.df <- flux.df[flux.df$X != 208,]

skewness(flux.df$fluxL)

#0.2774125

shapiro.test(flux.df$fluxL)

#W = 0.9909, p-value = 0.07308

#not great, but keep null hypothesis that data is normally distributed

#looks pretty good: proceed without log transform!

###############################################################################
##

###################### Repeated measures fluxL  ###################

###############################################################################
##

#setting up corAR1 lag variables and playing with David's suggestions

#AHT

varID <- 'AHT1'

assign(paste(varID,".ts", sep = ""), ts(flux.df$fluxL[flux.df$ID == varID]))

assign(paste(varID,".acf", sep = ""), acf(eval(as.name(paste(varID,".ts", sep = ""))), type =
"correlation"))

quartz()

varID <- 'AHT2'

assign(paste(varID,".ts", sep = ""), ts(flux.df$fluxL[flux.df$ID == varID]))
```

```
assign(paste(varID,".acf", sep = ""), acf(eval(as.name(paste(varID,".ts", sep = ""))), type =
"correlation"))
#CLC
quartz()
varID <- 'CLC1'
assign(paste(varID,".ts", sep = ""), ts(flux.df$fluxL[flux.df$ID == varID]))
assign(paste(varID,".acf", sep = ""), acf(eval(as.name(paste(varID,".ts", sep = ""))), type =
"correlation"))
quartz()
varID <- 'CLC2'
assign(paste(varID,".ts", sep = ""), ts(flux.df$fluxL[flux.df$ID == varID]))
assign(paste(varID,".acf", sep = ""), acf(eval(as.name(paste(varID,".ts", sep = ""))), type =
"correlation"))
#after viewing auto correlation function, it looks there is no temporal autocorrelation, so no need
for repeated measures
############################################################################
#Correlation
# Define correlation structure - regular time intervals
cs1 <- corAR1(form= ~ 1 | ID)#changed from plot to ID grouping
flux.cor<-gls(fluxL ~ cover * position, corr = cs1, data=flux.df)
#examining the autocorrelation of the model, (0.08? ish?) we confirmed that there is very little
auto correlation and we can simply use lm()
```

#doing linear model: low fitted correlation coefficient, go to simpler model, each chamber flux is independent

#we found that the interaction model is better than the additive, position or cover alone does not explain the data as well as the interaction

```
flux.lm <- lm(fluxL ~ cover * position, data = flux.df)
#Residuals:
#  Min        1Q     Median        3Q        Max
#-3.163e-07 -8.854e-08  1.077e-08  8.310e-08  4.425e-07


#Coefficients:
#                 Estimate Std. Error t value Pr(>|t|)
#(Intercept)       6.035e-08  1.582e-08   3.816 0.000167 ***
#  coverT          -3.755e-08  2.237e-08  -1.679 0.094293 .
#positionL        -4.105e-08  2.237e-08  -1.835 0.067512 .
#coverT:positionL  1.323e-07  3.169e-08   4.176 3.96e-05 *** #######significant interaction!!
#  ---
#  Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


#Residual standard error: 1.342e-07 on 283 degrees of freedom
#Multiple R-squared: 0.07543,    Adjusted R-squared: 0.06563         #explains ~ 6.5% of variation in data
#F-statistic: 7.696 on 3 and 283 DF,  p-value: 5.835e-05
################################################################################
```

```
#anova for flux.lm

anova(flux.lm)

#Response: fluxL

#                Df     Sum Sq    Mean Sq F value    Pr(>F)

#cover           1 5.7400e-14 5.7403e-14  3.1876   0.07527 .

#position        1 4.4400e-14 4.4386e-14  2.4647   0.11755

#cover:position   1 3.1400e-13 3.1398e-13 17.4349 3.963e-05 ***

#  Residuals      283 5.0964e-12 1.8008e-14

#---

#  Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


#check how good the model is:

par(mfrow=c(2,2))

plot(flux.lm$fitted,flux.lm$residuals,xlab="Fitted",ylab="Residuals")

plot((flux.df$date),flux.lm$residuals,xlab="Date",ylab="Residuals")

hist(flux.lm$residuals,main=" ", xlab="Residuals",ylab="Frequency")

qqnorm(flux.lm$residuals,main=" ", xlab="Theoretical quantiles",ylab="Sample quantiles")


skewness(flux.lm$residuals) #0.1854727


#what is the effect of the  #cover:position  interactions?

######################################################################

df<-df.residual(flux.lm)
```

```
MSerror<-deviance(flux.lm)/df

#or:

#mean square error MSE

MSerror <- (as.numeric(1.342e-07)^2)

#residual degrees of freedom

df <- 283


# Effect of #cover:position

LSD.test(flux.df$fluxL, flux.df$cover:flux.df$position, df, MSerror, p.adj="none",
group=TRUE)

#Groups, Treatments and means

#a      T:L     1.141e-07

#b      C:H     6.035e-08

#b      T:H     2.28e-08

#b      C:L     1.93e-08
```

Script 6:

Like script 4 and 5, this script loads the flux output file generated by script 3. It converts the data units and adjusts data into the final form presented in the paper.

```
#clear all variables
rm(list=ls())
#Load data files
#set working directory to source of csv files
setwd("./flux")
#loads flux tables from csv files
flux.df<-read.csv("FT_flux_613.csv", header = TRUE, sep = ",", quote="\"", dec=".", fill =
TRUE, comment.char="")
#convert fluxes from grams N2O m^-2 min-1 to ...... micrograms N2O-N m^-2 hr-1
flux.df$fluxL <- flux.df$fluxL * (10^6) * (28/44) * 60
#convert dates from string to date class
flux.df$date <- strptime(flux.df$date, format = "%Y-%m-%d")
#adjust datenumber to account for 1:49:30 pm time
flux.df$date <- ((flux.df$date) + ((49.5/60)+13)*3600)
#convert soil Temps to C
flux.df$Tavg <- ((flux.df$Tavg - 32) /1.8)
```

Works Cited

1. Adler PR, Del Grosso SJ, Parton WJ. Life-cycle assessment of net greenhouse-gas flux for bioenergy cropping systems. Ecol Appl. 2007;17(3):675-91.

2. Bessou C, Ferchaud F, Gabrielle B, Mary B. Biofuels, greenhouse gases and climate change. A review. Agronomy for Sustainable Development. 2011;31(1):1-79.

3. Hoefnagels R, Smeets E, Faaij A. Greenhouse gas footprints of different biofuel production systems. Renewable and Sustainable Energy Reviews. 2010;14(7):1661-94.

4. Sainju UM, Stevens WB, Caesar-Tonthat T, Liebig MA. Soil greenhouse gas emissions affected by irrigation, tillage, crop rotation, and nitrogen fertilization. Journal of environmental quality. 2012;41(6):1774-86. Epub 2012/11/07.

5. Forster P, V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz, R. Van Dorland. Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 2007.

6. Conrad R. Soil microorganisms as controllers of atmospheric trace gases (H-2, CO, CH4, OCS, N2O, and NO). Microbiol Rev. 1996;60(4):609-+.

7. Ravishankara A. Nitrous oxide (N2O): The dominant ozone-depleting substance emitted in the 21st century. Science. 2009;326.

8. Smith P, D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko. Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 2007.

9. U.S. EPA. Global Mitigation of Non-CO2 Greenhouse Gases: 2010-2030. Office of Atmospheric Programs (6207J) Washington, DC 20005. 2013.

10. Li C. Quantifying greenhouse gas emissions from soils: Scientific basis and modeling approach. Soil Science and Plant Nutrition. 2007;53(4):344-52.

11. Molodovskaya M, Singurindy O, Richards BK, Warland J, Johnson MS, Steenhuis TS. Temporal Variability of Nitrous Oxide from Fertilized Croplands: Hot Moment Analysis. Soil Sci Soc Am J. 2012;76(5):1728-40.

12. Corre MD, vanKessel C, Pennock DJ. Landscape and seasonal patterns of nitrous oxide emissions in a semiarid region. Soil Sci Soc Am J. 1996;60(6):1806-15.

13. Wagner-Riddle C. Estimates of nitrous oxide emissions from agricultural fields over 28 months. Canadian journal of soil science. 1997;77(2).

14. Christensen S, Tiedje JM. Brief and Vigorous N2o Production by Soil at Spring Thaw. J Soil Sci. 1990;41(1):1-4.

15. Dorsch P, Palojarvi A, Mommertz S. Overwinter greenhouse gas fluxes in two contrasting agricultural habitats. Nutr Cycl Agroecosys. 2004;70(2):117-33.

16. Wagner-Riddle C, Furon A, Mclaughlin NL, Lee I, Barbeau J, Jayasundara S, et al. Intensive measurement of nitrous oxide emissions from a corn-soybean-wheat rotation under two contrasting management systems over 5 years. Global Change Biol. 2007;13(8):1722-36.

17. Singurindy O, Molodovskaya M, Richards BK, Steenhuis TS. Nitrous oxide emission at low temperatures from manure-amended soils under corn (Zea mays L.). Agriculture, Ecosystems & Environment. 2009;132(1-2):74-81.

18. Matzner E, Borken W. Do freeze-thaw events enhance C and N losses from soils of different ecosystems? A review. European Journal of Soil Science. 2008;59(2):274-84.

19. Teepe R, Brumme R, Beese F. Nitrous oxide emissions from soil during freezing and thawing periods. Soil Biol Biochem. 2001;33(9):1269-75.

20. Teepe R, Vor A, Beese F, Ludwig B. Emissions of N2O from soils during cycles of freezing and thawing and the effects of soil water, texture and duration of freezing. European Journal of Soil Science. 2004;55(2):357-65.

21. Risk N, Snider D, Wagner-Riddle C. Mechanisms leading to enhanced soil nitrous oxide fluxes induced by freeze–thaw cycles. Canadian Journal of Soil Science. 2013;93(4):401-14.

22. Ludwig B, Wolf I, Teepe R. Contribution of nitrification and denitrification to the emission of N2O in a freeze-thaw event in an agricultural soil. J Plant Nutr Soil Sc. 2004;167(6):678-84.

23. Dietzel R, Wolfe D, Thies JE. The influence of winter soil cover on spring nitrous oxide emissions from an agricultural soil. Soil Biology and Biochemistry. 2011;43(9):1989-91.

24. Pelster DE, Chantigny MH, Rochette P, Angers DA, Laganière J, Zebarth B, et al. Crop residue incorporation alters soil nitrous oxide emissions during freeze–thaw cycles. Canadian Journal of Soil Science. 2013;93(4):415-25.

25. Wagner-Riddle C, Thurtell GW. Nitrous oxide emissions from agricultural fields during winter and spring thaw as affected by management practices. Nutr Cycl Agroecosys. 1998;52(2-3):151-63.

26. Smith KA, Thomson PE, Clayton H, McTaggart IP, Conen F. Effects of temperature, water content and nitrogen fertilisation on emissions of nitrous oxide by soils. Atmos Environ. 1998;32(19):3301-9.

27. Cline MG, Bloom AL. Soil survey of Cornell University property and adjacent areas. Ithaca: New York State College of Agriculture; 1965.

28. Parkin TB, Venterea RT. Sampling Protocols. Chapter 3. Chamber-Based Trace Gas Flux Measurements. Sampling Protocols RF Follett, editor. 2010: p. 3-1 to 3-39.

29. Molodovskaya M, Oberg G, Warland J, Richards BK, Steenhuis TS. Nitrous oxide from heterogeneous agricultural landscapes: Source contribution analysis by eddy covariance and chambers. Soil Sci Soc Am J Soil Science Society of America Journal. 2011;75(5):1829-38.

30. Rochette P, Bertrand N. Soil-Surface Gas Emissions, in: Soil Sampling and Methods of Analysis, 2n Ed: M.R. Carter and E.G. Gregorich eds. Canadian Journal of Soil Science. 2008.

31. Rochette P, Hutchinson GL. Measurement of Soil Respiration in situ: Chamber Techniques. In: Hatfield JL, Baker JM, editors. Micrometeorology in Agricultural Systems: American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America; 2005. p. 247-86.

32. Undersander D. Forage Analyses Procedures. National Forage Testing Association. 1993.